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# *Opuscula Philolichenum*

*small works in the field of lichenology*



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## MISSION

*Opuscula Philolichenum* is intended to serve as a venue for the publication of small works in the field of lichenology (including lichenicolous fungi and non-lichenized fungi traditionally treated with lichens). The central goal of the journal is to provide timely publication, in a professional format, free of charge to authors and readers. While the journal focuses on topics relating to the lichen biota of North America this is by no means exclusive and manuscripts on other topics will be considered as the table of contents of the present issue clearly illustrates.

Authors wishing to submit a manuscript for publication in *Opuscula Philolichenum* should contact the editor prior to submission to confirm that the paper conforms to the mission of the journal (outlined above). Manuscript submissions should be left unformatted and authors should consult a recent issue of *Opuscula Philolichenum* for style. All submissions are subjected to review by at least two peer reviewers and, following acceptance are formatted by the editor.

## NOTICE FROM THE EDITOR

When this journal began publication ten years ago it was among the first serials to take advantage of the internet when publishing new botanical nomenclatural acts. The journal was conceived as a primarily electronic one, available on-line free of charge (at http://sweetgum.nybg.org/philolichenum/), with a limited print run to satisfy the requirements for effective publication established under the *International Code for Botanical Nomenclature*. Since that time we have continued to publish the journal in this manner, printing one or two issues a year, with each issue consisting of between one and two hundred pages.

In 2004 we could not have foreseen the revolutionary changes that took place at the 18th International Botanical Congress in Melbourne. There the Nomenclature Section voted to allow electronic only publication of new nomenclatural acts beginning 1 January 2012. In response to this change *Opuscula Philolichenum* no longer produces hardcopy.

Beginning with volume number 12 of *Opuscula Philolichenum*, manuscripts are published electronically on-line in PDF/A format immediately following the approval of the authors in the post-review proof stage. The PDF issued online is considered to be the final version (= version of record) and the date on which the PDF is posted is considered to be the date of effective publication. In order to aid future workers the date of effective publication for each manuscript is provided in the table of contents. When a new manuscript is published online a record is also simultaneously transmitted to the organizers of *Recent Literature on Lichens* for inclusion in that database.

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# *Hueidea* – a genus to host former *Huea* species (Teloschistaceae, lichenized Ascomycota)

ULRIK SØCHTING[1]*, ULF ARUP[2], DAMIEN ERTZ[3], MARC LEBOUVIER[4], ALAN FRYDAY[5], FRANK BUNGARTZ[6,7], LEOPOLDO GARCIA SANCHO[8], GARY PERLMUTTER[9]

ABSTRACT. – The name *Huea*, used for a lichen genus which hosts the two common Antarctic species *H. cerussata* and *H. grisea* (= *H. coralligera*), was formally recommended for rejection by the Nomenclature Committee for Fungi. Based on molecular data, we transfer these two species to the genus *Hueidea*. *Hueidea* was originally described in the family Fuscideaceae for the single alpine Australian endemic species *Hueidea australiensis*. However, our molecular data show it belongs to the Teloschistaceae and we here transfer it to that family. Two additional species, *Huea sorediata* and *Caloplaca coeruleofrigida* from Antarctica are also transferred to *Hueidea* and a new species, *H. austroaquatica*, is described from the Kerguelen Islands. The acetone-insoluble pigment, which occurs at different concentrations in the apothecia of all *Hueidea* species, is shown to be *cinereorufa*-green. *Hueidea coeruleofrigida* is the only species in the genus known to produce anthraquinones in the apothecia.

KEYWORDS. – Antarctica, *cinereorufa*-green, insoluble pigments, Kerguelen.

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## INTRODUCTION

The genus *Huea* C.W. Dodge & G.E. Baker was established by Dodge and Baker (1938) for a small group of Antarctic species in the family Teloschistaceae Zahlbr. that was characterized by lacking anthraquinones and having black apothecia with a carbonaceous exciple and a bright blue epihymenium. Hue (1915), who first described two Antarctic species of this complex as *Lecidea cerussata* Hue and *L. coralligera* Hue, noted that they formed a distinct group: "l'enveloppe de l'apothécie est entièrement colorée en brun ou en noir, comme dans la plupart des espèces qui appartiennent aux vrais *Lecidea*" (= "the excipulum is totally brown or black, like the majority of species of true *Lecidea*"; Hue 1915: 102). Dodge and Baker (1938) transferred the above two species to their new genus as *Huea cerussata* (Hue) C.W. Dodge & G.E. Baker and *H. coralligera* (Hue) C.W. Dodge & G.E. Baker, but chose as the type species their newly described species, *Huea flava* C.W. Dodge & G.E. Baker.

Dodge (1948) subsequently added two further species to *Huea*: *H. diphyella* (Nyl.) C.W. Dodge from the Kerguelen Islands in the southern Indian Ocean, and *H. smaragdula* C.W. Dodge from Antarctica. *Huea smaragdula* was later shown by Castello and Nimis (1995) to be a synonym of *Carbonea capsulata* (C.W. Dodge & G.E. Baker) Hale. Based on a very broad concept of the genus, Dodge (1971) later transferred numerous other species, mostly from tropical Africa, to *Huea*. The vast majority, if not all of these, are probably unrelated to *H. cerussata* and *H. coralligera* (the latter now recognized as *H. grisea* (Vain.) I.M. Lamb) and should most likely be accommodated in other genera of the Teloschistaceae. This, however, remains to be studied. Finally, *H. sorediata* Øvst. was described by Øvstedal & Smith (2001) based on morphological similarity to *H. cerussata*.

The type specimen of *Huea flava* was shown by Fryday (2011) to be conspecific with *Carbonea capsulata*. This resulted in the inconvenient consequence that the genus name *Huea* is an earlier name for *Carbonea*. In order to avoid a significant number of nomenclatural changes Fryday et al. (2022) proposed to conserve the name *Huea* in its current application with the conserved type species, *H. cerussata*. This proposal was rejected by the Nomenclature Committee for Fungi, which made the counterproposal to formally reject the genus name *Huea* under Article 56 of the *Shenzhen Code* (Turland et al. 2018) although the *Huea* combinations remain valid and legitimate (May & Lendemer 2023).

In order to establish the correct systematic position of the species formally included in *Huea*, we performed a molecular study of the *Huea* species with available molecular data, also taking into account the genus *Hueidea* Kantvilas & P.M. McCarthy that was described from alpine Australia (Kantvilas & McCarthy 2003) in the family Fuscideaceae. Despite having been described in a distantly related family and order, *Hueidea* was known by us to be phylogenetically related to *Huea* based on unpublished molecular data from the type species. Our molecular study also included the Antarctic species *Caloplaca coeruleofrigida* Søchting & Seppelt, and a species from the Kerguelen Islands that we describe here as new to science, both of which we also knew to be related to *Hueidea* based on previously unpublished data. Here we present the results of our study that demonstrate that *Hueidea* belongs to the Teloschistaceae and conveniently provides an existing name for the species previously included in *Huea*. We provide the necessary new combinations from *Huea* to *Hueidea*. We also suggest which taxa likely do not belong to *Hueidea* and require further study to determine their taxonomic placement.

## MATERIALS AND METHODS

The study is based on, primarily, fresh collections from Livingston Island, Antarctica (Figure 1) deposited in the herbarium of the University of Copenhagen (C), supplemented with specimens from the following herbaria: BM, BR, C, HO and LD. Collection localities for all voucher specimens are given for each collection.

**MORPHOLOGY AND ANATOMY**. – Macroscopic descriptions are based on observations made with an Olympus SZH dissecting microscope with an Olympus OM-D camera. Sections were made by hand and studied with a Leitz Orthoplan compound microscope. All measurements were made on material mounted in water. Ascospores were measured outside their asci and dimensions are given as averages and standard deviation of 'n' measurements with minimum and maximum measurements in parentheses.

**SECONDARY CHEMISTRY.** – Secondary metabolites were identified using HPLC according to Søchting (1997). The relative composition of the secondary compounds was calculated based on

**Figure 1.** Typical habitat of *Hueidea cerussata* and *H. grisea* that grow on pebbles by the ocean as illustrated by the site at Caleta Española with the Spanish Antarctic Base (Juan Carlos I), on Livingston Island, Antarctica.

absorbance at 270 nm according to Søchting (1997). All yellow, orange or reddish-pigmented parts of the lichens are K+ purple, indicating anthraquinones. Unextractable pigments of internal apothecial structures were analyzed on thin sections according to the methodology of Meyer and Printzen (2000).

**MOLECULAR ANALYSES.** – PCR amplification was carried out on DNA extracts or using direct PCR following Arup et al. (2015). Amplifications were made of the internal transcribed spacer regions (nrITS) and the large subunit (nrLSU) of the nuclear ribosomal RNA genes, and the small subunit of the mitochondrial ribosomal RNA gene (mrSSU). Primers for amplification were ITS1F (Gardes & Bruns 1993), ITS4 (White et al. 1990), AL1R (Döring et al. 2000), LR5 or LR6 (Vilgalys & Hester 1990), mrSSU1 (Zoller et al. 1999) and mrSSU7 (Zhou & Stanosz 2001). The PCR parameters included an initial hold at 94C° for 5 min, then denaturating at 94C° for 1 min, annealing at 50 or 54C° (mrSSU) or 53–56C° (nrITS and nrLSU) for 1 min, decreasing 1C° per cycle for the first 6 of the 39 cycles (touchdown), and extension at 72C° for 3 min.

Sequences were generated by Macrogen Inc., the Netherlands, using the same primers as for the PCR. The two resulting strands were assembled using CLC Main Workbench 4.1.2 ™ or Geneious 11.1.5.

**SEQUENCE ALIGNMENT.** – From BLAST searches and a previous, unpublished phylogenetic analysis of sequence data, it has been clear to us that the genus *Huea* as circumscribed by the Antarctic species belongs in the family Teloschistaceae, subfamily Caloplacoideae. Therefore, representatives of all genera accepted by us of this subfamily were downloaded from GenBank and added to our own data. Subsequent alignments for each of the three genes were made in Geneious 11.1.15 using the MAFFT option (auto) and adjusted manually. Unalignable ends, introns in all the aligned genes, and ambiguously aligned parts were excluded from the alignment. The alignments were first analysed separately to check for incongruence between genes, but none was found. A conflict between the datasets was assumed to be significant if two different relationships were both supported with posterior probabilities of 0.95 or higher. A combined analysis of the genes nrITS, nrLSU and mrSSU was carried out using the outgroup species *Amandina punctata* (Hoffm.) Coppins & Scheid. and *Physcia aipolia* (Ehrh. ex Humb.) Fürnr. shown to be related to Teloschistaceae (Gaya et al. 2012) and used as outgroup in several subsequent studies (e.g., Arup et al. 2013). Newly generated sequences were submitted to GenBank and the accession numbers are provided in Table 1 (see Appendix I).

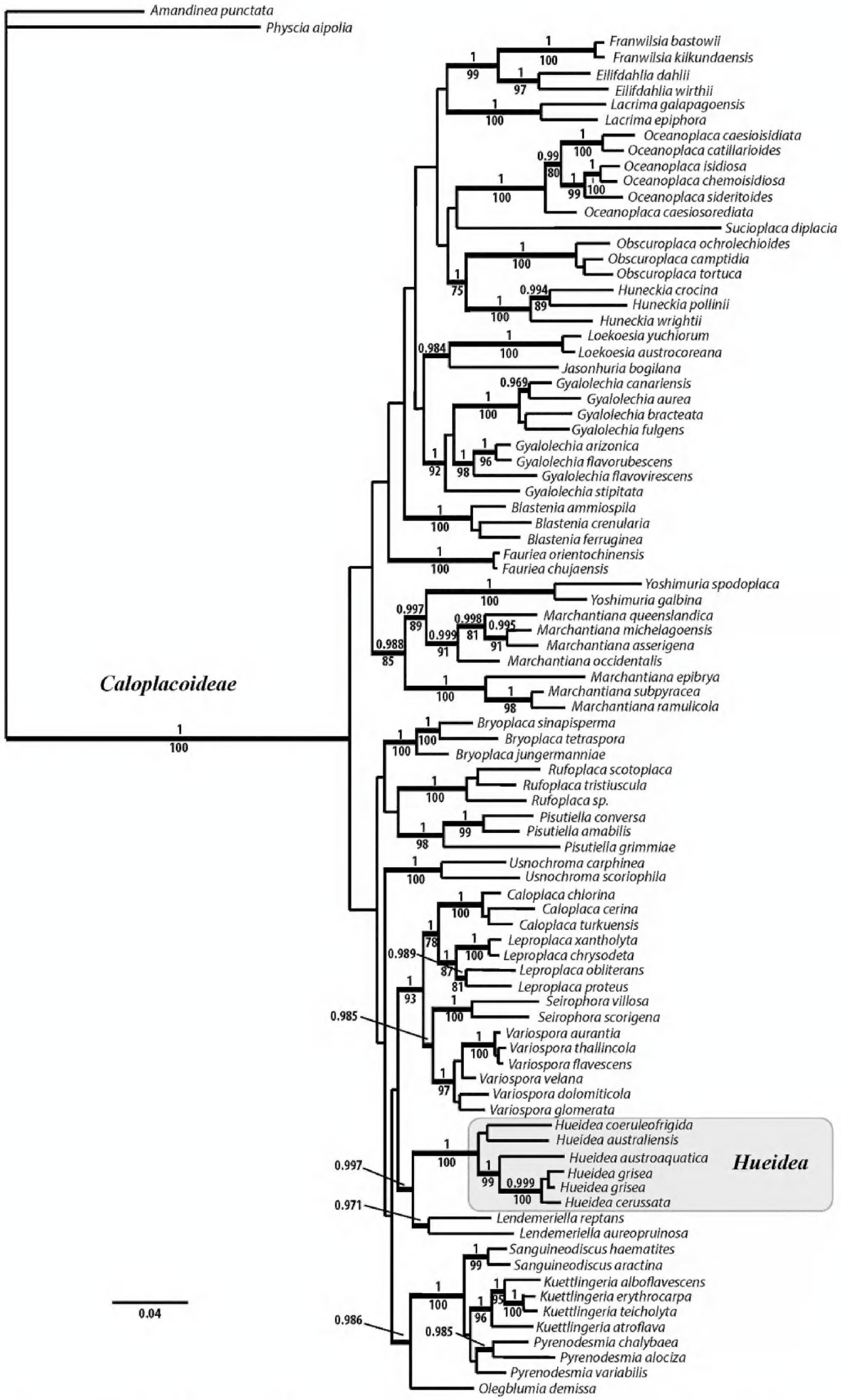


**Figure 2.** Phylogenetic tree of *Hueidea* and its relatives based on a Bayesian analysis of a combined dataset of nrITS, nrLSU, and mrSSU data. Posterior probabilities are given above the branches and Maximum Likelihood bootstrap values are given below the branches.

**PHYLOGENETIC ANALYSIS.** – Phylogenetic relationships were inferred using Maximum Likelihood (ML) as implemented in IQ-TREE (Quang Minh et al. 2020) and Bayesian tree inference was carried out using Markov chain Monte Carlo (MCMC) as implemented in MrBayes version 3.2 (Ronquist et al. 2012). In the combined analysis the three included genes were treated as separate partitions. A suitable likelihood model for each of the genes was selected, using BIC as implemented in the software jModeltest version 2.1.4 (Guindon & Gascuel 2003; Darriba et al. 2012), evaluating only the 24 models available in MrBayes (Ronquist et al. 2012). For all three partitions the model GTR+G+I was found to be optimal. The parameters used in the analyses followed those of Arup et al. (2013) except for the branch length prior that was set to an exponential with mean 1/10. In the Bayesian analyses three parallel runs with 20 000 000 generations starting with a random tree and employing 6 simultaneous chains was executed, of which 5 were incrementally heated with a temperature of 0.10. Analyses were diagnosed every 1000 generations and automatically halted when convergence was reached. Convergence was defined as a standard deviation of splits (of frequency 0.1) between runs below 0.01. Every 2000th tree was sampled. A majority-rule consensus tree was constructed from the post-burn-in tree samples. The consensus trees were visualized using FigTree 1.4.4 and re-drawn in Adobe Illustrator. The Maximum Likelihood analyses used the same evolutionary models as in the Bayesian analyses. Branch support values were computed via 1000 non-parametric bootstrap replicates.

## RESULTS AND DISCUSSION

**SYSTEMATIC PLACEMENT.** – The monotypic Australian genus, *Hueidea* was placed in the Fuscideaceae (Umbilicariales) by Kantvilas and McCarthy (2003). Extensive justification was provided by those authors for the systematic placement of *Hueidea* at the time it was described. Nonetheless, it is here shown to belong in the Teloschistaceae (Teloschistales). It is enlarged here to include *H. cerussata*, *H. coeruleofrigida*, *H. grisea, H. sorediata*, and a new species, described below as *Hueidea austroaquatica*. All species, except for *H. coeruleofrigida*, lack anthraquinones but their persistently lecideine apothecia are internally pigmented with *cinereorufa*-green; *sedifolia*-grey is not present. The proper exciple is either reduced or well developed. In addition to the presence of *cinereorufa*-green and absence of *sedifolia*-grey pigments in the apothecia the species are united by molecular characters. They are currently known from alpine habitats in Australia and from Antarctic, and Subantarctic regions.

**MOLECULAR RESULTS.** – We generated 12 new sequences for this study (Table 1). In the combined data set of 90 sequences, the nrITS partition consisted of 521 sites (290 informative), the nrLSU partion consisted of 708 sites (135 informative), and the mrSSU partition of 807 sites (188 informative). The Bayesian analysis halted after 3 500 000 generations and a 50% majority-rule tree is shown in Figure 2. The Maximum Likelihood analysis yielded trees (not presented) similar to the Bayesian ones and bootstrap values are shown mapped onto the Bayesian tree in Figure 2.

In the phylogenetic analyses, *Hueidea australiensis* formed a fully supported clade (1/100) together with the originally described *Huea* species, *H. cerussata* and *H. grisea*. In addition, *Caloplaca coeruleofrigida* and the newly described species *Hueidea austroaquatica* (see below) also belong to this clade. The genus *Hueidea* appears to be a sister clade to the genus *Lendemeriella* S.Y. Kondr., a relationship that is strongly supported by the posterior probability value of 0.98, but not by the bootstrap analysis.

**CHEMICAL RESULTS.** – Anthraquinones, specifically the type A chemosyndrome of Søchting (1997; dominant parietin and minor proportions of teloschistin, fallacinal, parietinic acid and emodin), could be confirmed by HPLC only for *H. coeruleofrigida*. All other species in the genus do not appear to produce anthraquinones or other acetone-extractable secondary metabolites.

*Hueidea cerussata* and *H. grisea* have identical apothecial pigmentation with an emerald green epihymenium and a brownish hypothecium extending up the proper exciple (Figure 3). With the addition of 10% KOH (K) there is hardly any colour change but with 50% $NHO_3$ (N) the emerald pigment turns red/magenta. Subsequent addition of K changed the epihymenium color pale greenish. These reactions correspond to those of *cinereorufa*-green of Meyer and Printzen (2000). Only one specimen of *H. australiensis*, *H. austroaquatica* and *H. coeruleofrigida*, respectively, was analysed, but they all seem to share the same pattern of pigments in their apothecia, albeit with varying intensity. Characteristic is the

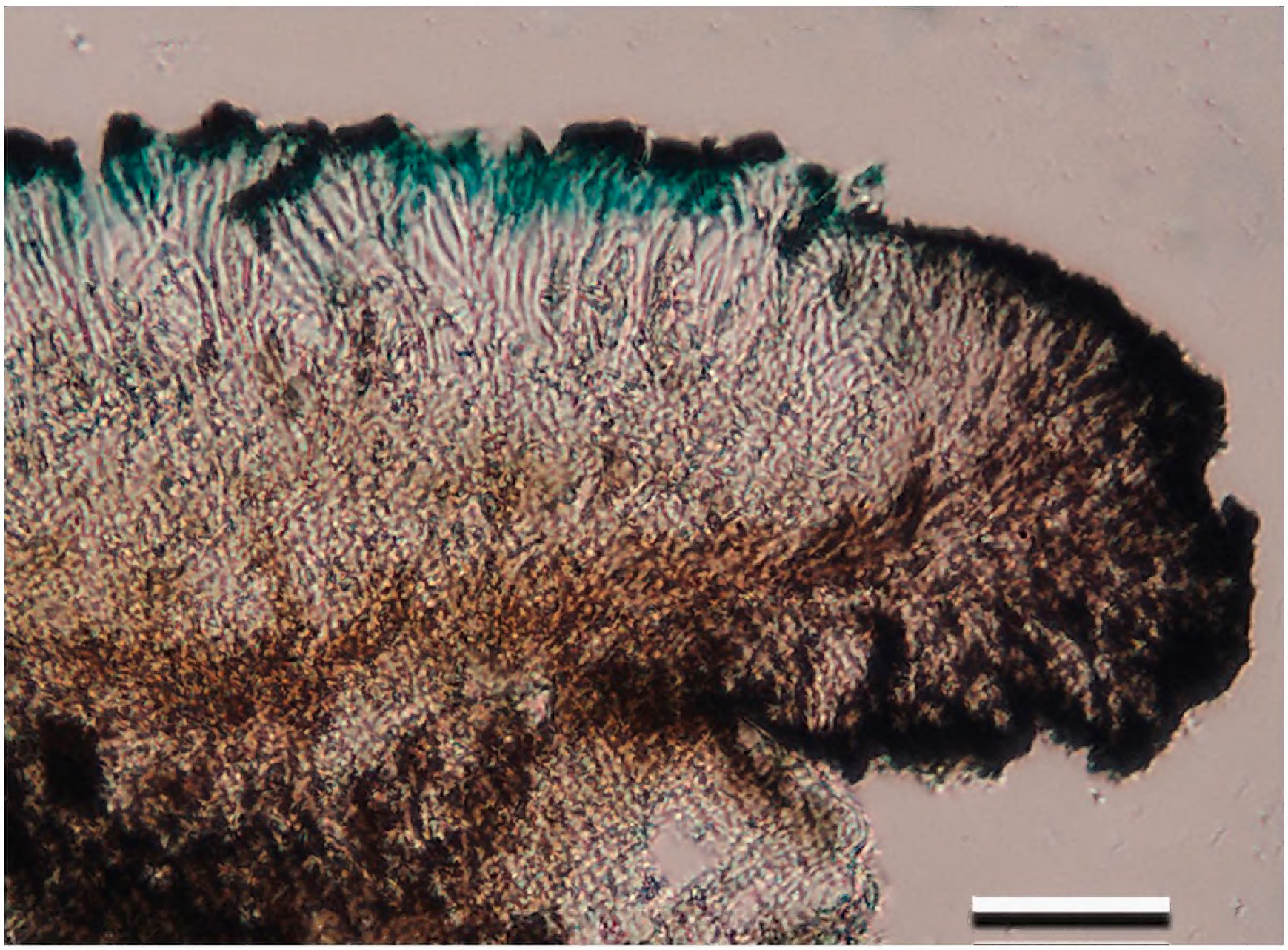

**Figure 3.** Section of apothecium of *Hueidea grisea* in water (*Sancho s.n.*, C), illustrating in particular the brownish hypothecium and emerald pigmentation of the epihymenium. Scale = 50 µm.

more or less greenish pigmentation of the epihymenium and upper part of the hymenium, which does not change when K is added, but turns magenta or pinkish with N, and more or less greenish with subsequent addition of K. The intensity of the colors may be due to quantitative differences of these pigments, but the detailed chemistry of the apothecial pigments such as *cinereorufa*-green so far remains unresolved (Meyer & Printzen 2000).

It is significant that none of the species has been shown to produce *sedifolia*-grey, another blackish grey-green pigment common in Teloschistaceae (Frolov et al. 2020, Vondrák et al. 2013).

## TAXONOMIC SECTION

***Hueidea*** Kantvilas & P.M. McCarthy, Lichenologist 35(5–6): 398. 2003.
Mycobank #28745.
**GENERIC TYPE:** *Hueidea australiensis* Kantvilas & P.M. McCarthy, Lichenologist 35(5–6): 399. 2003.

= *Huea* C.W. Dodge & G.E. Baker, Ann. Missouri Bot. Gard. 25(2): 617. 1938. *nom. rej.*
Mycobank #2370.
**GENERIC TYPE:** *Huea flava* C.W. Dodge & G.E. Baker, Ann. Missouri Bot. Gard. 25(2): 618. 1938.

**NOTES**. – Based on a thorough discussion by the describing authors (Kantvilas & McCarthy 2003) the genus *Hueidea* was classified in the family Fuscideaceae, but the authors expressed some uncertainty concerning an alternative affiliation to Teloschistaceae. Our molecular studies clearly place it in the Teloschistaceae.

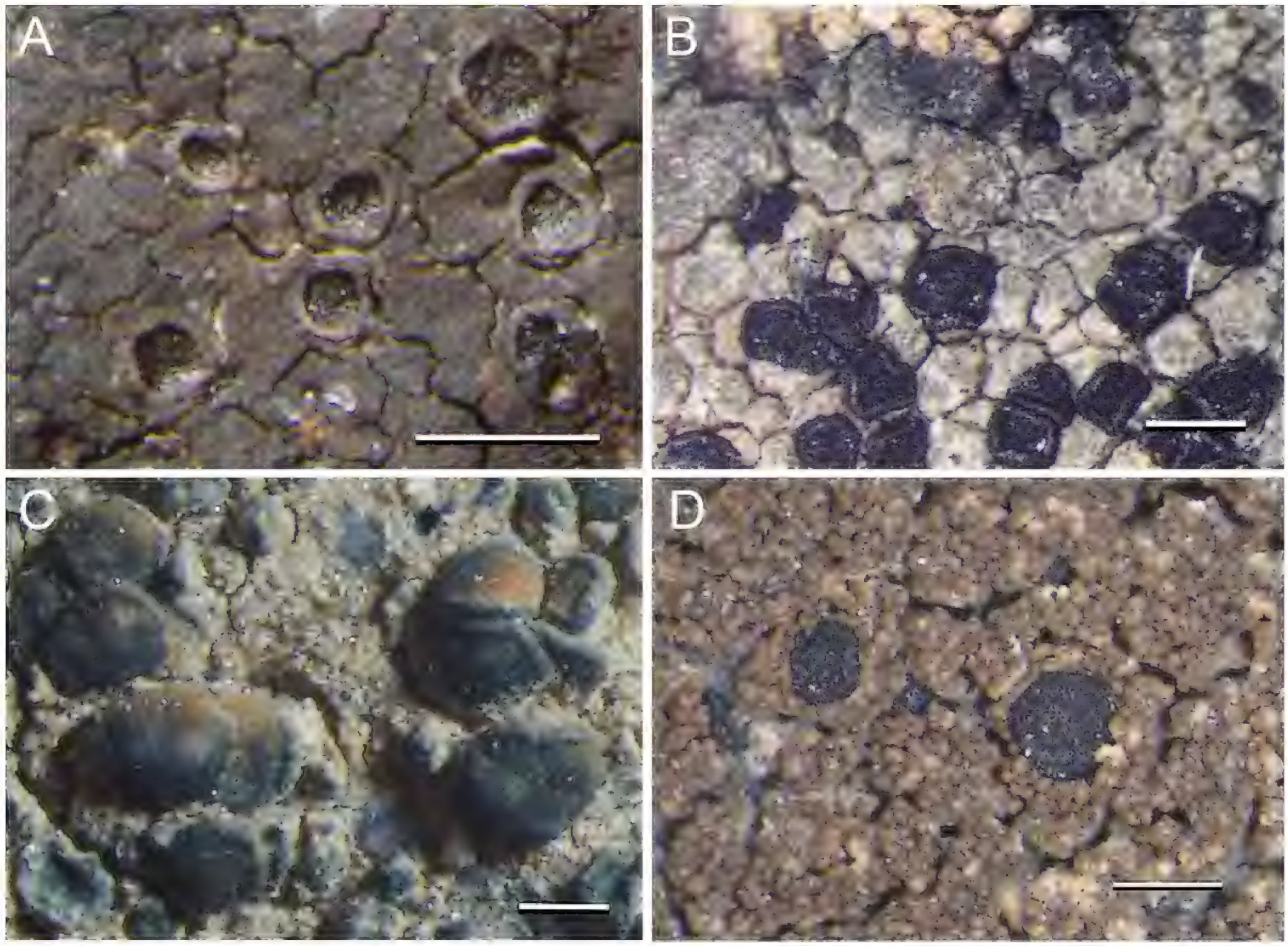


**Figure 4**. Morphological variation among selected *Hueidea* species treated here. **A,** isotype of *H. australiensis* (*McCarthy 1807*, HO). **B,** voucher of *H. cerussata* from Livingston Island (*Sancho s.n.*, C). **C,** holoype of *H. coeruleofrigida* (*Seppelt 19864*, C). **D,** voucher of *H. grisea* from Livingston Island (*Sancho s.n.*, C). Scales = 0.5 mm.

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***Hueidea australiensis*** Kantvilas & P.M. McCarthy, Lichenologist 35(5–6): 399. 2003. **TYPE**: **AUSTRALIA.** NEW SOUTH WALES: Kosciuszko National Park, Rams Head Range, 1980 m. alt., 2002, on seasonally inundated granite, *P.M. McCarthy 1807* (CANB[n.v.], holotype; HO!, isotype).
Mycobank #481110.

**FIGURE 4A.**

**Notes**. – It is significant that the climate at the type locality, with average summer temperatures of only 10°C (Kantvilas & McCarthy 2003), approached that of *H. austroaquatica* (see below), *H. cerussata* and *H. grisea,* even though the last two species inhabit coastal rocks.

***Hueidea austroaquatica*** Ertz & Søchting sp. nov.
Mycobank #853228.

**DIAGNOSIS**. – Similar to *Hueidea australiensis*, but with the apothecia not sunken into the thallus. Thallus crustose, bluish-black, rimose; apothecia darker, closely adnate, with only a slightly elevated margin, a brownish hypothecium and containing *cinereorufa*-green resulting in blue-green pigments particularly in the epihymenium. Ascospores polardiblastic, 12.7–18.7 × 6.9–9.4 µm; septum 2–4.5 µm thick. Phylogenetically well separated from all known members of the genus. On temporarily flushed rock.

**TYPE**: Kerguelen Islands, Grande Terre, Port-Jeanne d'Arc. 49°33′46″S, 69°48′47″E, ca. 190 m. alt., 23.i.2014, rocher dans le lit d'un ruisseau, *D. Ertz 19067* (BR!, holotype; C!, isotype).

**FIGURE 5**.

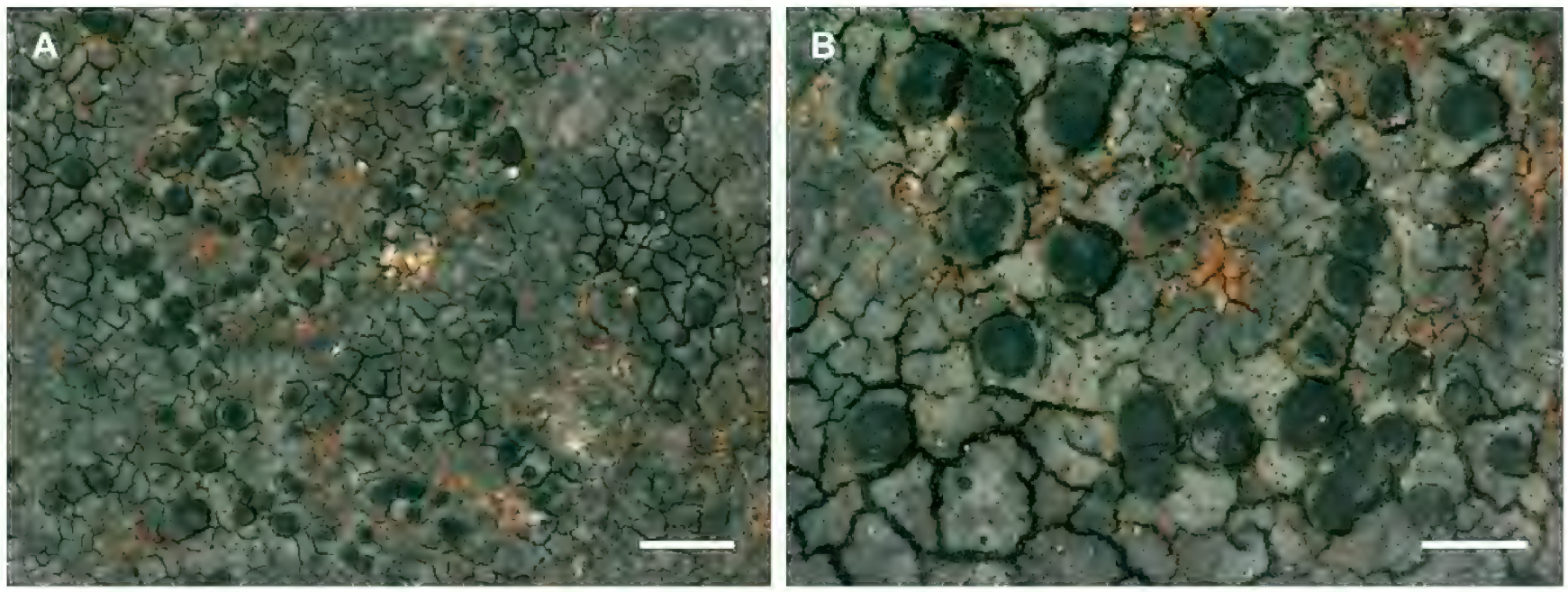


**Figure 5.** Morphology of *Hueidea austroaquatica* (all from the holotype, *Ertz 19067*, BR). **A and B,** thallus and ascomata. **C,** section of apothecium in water. **D,** photobiont in KOH. **E,** ascus and paraphyses in water. **F,** ascospores in water. **G,** ascospores in KOH. Scales = 1.0 mm in A, 0.5 mm in B, 50 µm in C; 10 µm in E, and 5 µm in D, F and G.

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**DESCRIPTION**. – Thallus crustose, saxicolous, rimose-areolate, dark bluish grey to black, ca. 100–250 µm thick; areoles irregular in outline, ±flat, smooth, ca. 100–450(–580) µm diam; cortex paraplectenchymatous, bluish black, 7–10 µm thick, composed of isodiametric cells ca. 3–5 µm diam.; hypothallus black, visible at the thallus periphery. Photobiont a green alga; cells 9–18 × 9–14 µm diam.

Apothecia lecideine, black, rounded, ca. 230–480 µm diam., immersed in the thallus when young, becoming ± semi-emergent, without a constricted base, one or two per areole; apothecial margin thin, ca. 30–50 µm thick, black, smooth, ± level with the hymenial disc when young and mature; hymenial disc black, flat or slightly convex, epruinose. Excipulum dark reddish brown, often with a cyan tinge near the

surface, ca. 24–33 µm thick laterally, sometimes widening to ca. 47 µm, lacking thalline tissue and photobiont cells. Hymenium clear, hyaline to pale cyan, 65–90 µm tall, I+ dark blue, KI+ dark blue; epihymenium dark brownish with a cyan tinge, K–. Paraphyses numerous, simple, 2–2.7 µm wide (in KOH), often slightly constricted at the septa, with the terminal cell slightly wider, up to ca. 4–5 µm wide, often with a cap of dark cyan pigment. Hypothecium dark brown below, pale brown above, ca. 90–130 µm thick, K–. Asci ellipsoid to clavate, 8-spored, ca. 50–70 × 18–22 µm (n=5), with a thickened apical wall. Ascospores hyaline, polardiblastic, ellipsoid, (12.7–)15(–18.7) × (6.9–)8.0(–9.4) µm (n=30, from three different apothecia), (15.4–)17.2(–19.8) × (8.7–)9.5(–10.3) µm (n=21, in KOH, from two additional apothecia); septum 2–4.5 µm thick (3.8–6.5 µm thick in KOH); with a very thin gelatinous sheath. Conidiomata not observed.

**CHEMISTRY.** – No acetone soluble compounds detected.

**DISTRIBUTION AND ECOLOGY.** – *Hueidea austroaquatica* is known only from its type locality in the Kerguelen Islands, growing on a rock in a river.

**ETYMOLOGY.** – The epithet refers to the Southern Hemisphere distribution and sub-aquatic habitat of the species.

**NOTES**. – The new species differs from *Huea diphyella* and other species of the genus *Hueidea* by having the combination of the following characters: semi-immersed and small (<0.5 mm diam.) ascomata with a non-prominent margin, a thick and dark thallus (bluish black cortex), a K– hypothecium and a subaquatic habitat. Moreover, *H. austroaquatica* is the sister species to the subclade formed by *H. cerussata* and *H. grisea* within the *Hueidea* clade in our phylogenetic tree.

***Hueidea cerussata*** (Hue) Søchting & Arup comb. nov.
Mycobank #853229.

≡ *Lecidea cerussata* Hue, Deux. Expéd. Antarct., bot., p. 101. 1915. ≡ *Blastenia cerussata* (Hue) Darb., British Antarctic ("Terra Nova") Expedition, 1910: Natural history reports, part 3: 54. 1923. ≡ *Huea cerussata* (Hue) C.W. Dodge & G.E. Baker, Ann. Missouri Bot. Gard. 25: 618. 1938. ≡ *Yoshimuria cerussata* (Hue) S.Y. Kondr., Kärnefelt, Elix, A. Thell, Jung Kim, A.S. Kondr. & Hur, in Kondratyuk, Jeong, Yu, Kärnefelt, Thell, Elix, Kim, Kondratiuk & Hur, Acta Bot. Hung. 56(1-2): 113. 2014. **TYPE**: **ANTARCTICA:** Ilot Goudier, Port-Lockroy, près de 1'île Wiencke, Chenal de Roosen, 28.xii.1908, sur les rochers (diorites), dans les endroits humides, *"III^e excursion" 112* (P!, holotype).

= *Caloplaca austroshetlandica* (Zahlbr.) Olech & Søchting, Lichenologist 25(3): 264. 1993. ≡ *Blastenia austroshetlandica* Zahlbr., Kongl. Svenska Vetensk. Acad. Handl. 57(6): 47. 1917. ≡ *Huea austroshetlandica* (Zahlbr.) C.W. Dodge, Lich. Fl. Antarct. Cont. adjac. Isls (Canaan, N. Hamp.): 252. 1973. **TYPE**: **ANTARCTICA:** South Shetland Islands, Nelson Island, rock with *Buellia nelsoni*, 11.i.1902, *C. Skottsberg* "*35. 37.*" (S-L12839[n.v.], holotype).

**FIGURE 4B.**

**NOTES**. – Øvstedal & Smith (2001) studied the type of *Blastenia austroshetlandica* Zahlbr. in W and included it as a synonym of *Huea cerussata*.

In their study of the Teloschistaceae, Gaya et al. (2015) included an mtSSU sequence (KT291519) and an RPB1 sequence (KT291601) that were assigned to *Huea cerussata* and allegedly originated from a voucher collected by one of the present authors (U. Søchting) in South America. This material is in fact identical with the voucher (*Søchting 7628*, C!) of *H. cerussata* and was collected on Livingston Island, Antarctica.

Kondratyuk et al. (2014) included *Huea cerussata* in their new genus *Yoshimuria* S.Y. Kondr., Kärnefelt, Elix, A. Thell & Hur (as *Y. cerussata* (Hue) S.Y. Kondr. et al.) based on a sequence (KJ021248.1) that was allegedly collected in King George Island, Antarctica. As a considerable number of sequences now confirm that this species belongs in *Hueidea* and not in the quite unrelated genus *Yoshimuria*, it is clear that its placement in *Yoshimuria* is incorrect. It is unlikely that a species of *Yoshimuria*, a genus that is otherwise known only from East Asia, occurs in Antarctica. We believe that the

results of Kondratyuk et al. (2014) may be due to an error in the connection between the analyzed sequence data and the source voucher specimen.

***Hueidea coeruleofrigida*** (Søchting & Seppelt) Søchting & Arup comb. nov.
Mycobank #853231.

≡ *Caloplaca coeruleofrigida* Søchting & Seppelt, Mycotaxon 86: 163. 2003. **TYPE**: **ANTARCTICA:** Southern Victoria Land, Granite Harbour, small stones in bubble in block boulder field at lower end of coastal slopes, 1992, *R.D. Seppelt 19864* (C!, holotype; HO!, isotype).

**FIGURE 4C.**

**NOTES**. – Based on all three sequenced genes, *H. coeruleofrigida* is sister to *H. australiensis*, and thus strongly supported to be a central member of the genus *Hueidea*. In spite of growing in the Antarctic continent on rocks that are ephemerally wet or humid along water courses its position within *Hueidea* is surprising given that it contains anthraquinones of chemosyndrome A.

***Hueidea grisea*** (Vain.) Søchting & Arup comb. nov.
Mycobank #853232.

≡ *Pertusaria grisea* Vain., Résult. Voy. Belgica, Bot.: 22. 1903. ≡ *Huea grisea* (Vain.) I.M. Lamb, Brit. Antarct. Surv., Sci. Rep. 61: 19. 1968. **TYPE**: **ANTARCTICA:** Chenal de Neumayer, sur un rocher à l'Ile Wienche, "64°48'S (15e débarquement)", 1898, *E.G. Racovitza 447p.p.* (TUR-VAINIO 06669!, holotype).

= *Lecidea coralligera* Hue, Deux. Expéd. Antarct., bot., p. 102. 1915. ≡ *Blastenia coralligera* (Hue) Darb., British Antarctic ("Terra Nova") Expedition, 1910: Natural history reports, part 3: 54. 1923. ≡ *Huea coralligera* (Hue) C. W. Dodge & G. E. Baker, Ann. Missouri Bot. Gard. 25(2): 618. 1938. **TYPE**: Ile Booth-Wandel, sur les rochers de la colline Jeanne, 30-100 m alt., "IVe excursion, no 115", 30.xii.1908 (P!, lectotype, selected by Søchting et al. 2004: 634).

= *Pyrenodesmia vernadskiensis* S.Y.Kondr., Kondratiuk, T.O. & Parnikoza, I. Yu., *in* Kondratyuk, Lőkös, Oh, Kondratiuk, Parnikoza & Hur. Acta Bot. Hung. 62(3–4): 257. 2020. **TYPE**: **ANTARCTICA:** Antarctic Peninsula, Argentine Islands, Winter Island, 2.iii.2020, *I. Parnikoza, s.n.* (KW-L[n.v.], holotype).
Mycobank #836739.

**FIGURE 4D.**

**NOTES**. – *Pyrenodesmia vernadskiensis* was claimed by the describing authors to be different from *H. grisea* based mainly on having an exclusively microfruticose thallus and other subtle anatomical differences, but based on the original diagnosis (Kondratyuk et al. 2020) and pending molecular examination, we include it as a synonym of *H. grisea*.

***Hueidea sorediata*** (Øvst.) Søchting comb. nov.
Mycobank #853233.

≡ *Huea sorediata* Øvst. in Øvstedal & Lewis Smith, Lichens of Antarctica and South Georgia, A Guide to Their Identification and Ecology, p. 193. 2001. **TYPE**: **SOUTH ORKNEY ISLANDS:** Signy Island, north of Spindrift Rocks, dry rock face near giant petrel colony, 30 m. alt., 6.ii.1992. *R.I. Lewis Smith 8603* (AAS!, holotype).
Mycobank #474445.

**NOTES**. – This species was described as a sorediate counterpart of *Huea cerussata* and was accordingly placed into *Huea*. There is no molecular data available to support its classification, but its similarity to *H. cerussata* merits its transfer into *Hueidea* and prevents it from becoming an orphaned species.

## HUEA SPECIES CURRENTLY NOT TRANSFERRED TO HUEIDEA

The following species were assigned to the genus *Huea* by Dodge (1971), but their generic affinities can be ascertained only after detailed molecular and/or chemical analyses that were beyond the scope of this study. The published provenance of the type material is indicated in parentheses following each name.

*Huea albidocoerulescens* (Müll. Arg.) C.W. Dodge (Arabian Sea: Yemen: Socotra)

*Huea albidofusca* (Nyl.) C.W. Dodge (North Africa: Egypt)

*Huea apostatica* (Nyl.) C.W. Dodge (Indian Ocean: Mauritius: Rodriques Island).

**NOTES**. – Transferred to the genus *Loekoesia* S.Y. Kondr., S.-O. Oh & Hur by Diederich and Ertz (2020) owing to the morphological similarity and the close phylogenetic relationship with *L. austrocoreana* S.Y. Kondr., Jung Kim, A.S. Kondr., S.O. Oh & Hur.

*Huea aspicilioidea* (Zahlbr.) C.W. Dodge (Southern Africa: South Africa)

*Huea comorensis* (Zahlbr.) C.W. Dodge (East Africa: Comoro Archipelago)

*Huea confluens* (Müll. Arg.) C.W. Dodge (Southwest Africa: Namibia)

*Huea cretacea* (Müll. Arg.) C.W. Dodge (Arabian Sea: Yemen: Socotra)

*Huea diphyella* (Nyl.) C.W. Dodge (South Atlantic Ocean: Kerguelen Island).

**NOTES**. – The protologue (Crombie 1876) reads: "A peculiar species, allied apparently to *Lecanora diphyes* Nyl., but differing in the smaller apothecia, the black hypothecium (K+violet-purple), and the thicker spores. Spermogones not seen. Saxicole". On the sheets of the two type specimens in London and Helsinki Nylander drew polarilocular spores. Here we select the specimen in BM as the lectotype because it was studied by Crombie and agrees with the protologue (Kerguelen Island, Observatory Bay, Royal Sound, ii.1875, [Venus-Transit Expedition 1874] *A.E. Eaton s.n.*, (BM!, lectotype, **designated here** MBT#10021914; H!, isolectotype). It should be noted that Øvstedal & Smith (2001: 192) cited the isolectotype in H as "type" but their citation cannot be construed as an inadvertent lectotypification because it was published after 1 January 2001 (Art. 7.11, 9.23; Turland et al. 2018). While Dodge (1948: 228) also listed a "type" for this name, he cited only the gathering and no herbaria. He also appended "type fide Nylander" to the description of the species (Dodge 1948: 228) and cited a range of ascospore sizes, however again no herbarium was cited. Given that Dodge could not have physically reviewed the type material (see below), and the lack of a citation of a herbarium, his publication cannot also be construed as having lectotypified the name.

Dodge (1948) transferred *Lecanora diphyella* to *Huea*, mainly based on the lack of anthraquinones. Because of the "war conditions" he was not able to consult the type material in Kew and Helsinki (Dodge 1948: 7), but instead based his description on one collection from Kerguelen (Observatory Bay, *B.A.N.Z.A.R.E. B192-10*). Based on microscopical comparison with type material in Helsinki, Øvstedal and Smith (2001) reported the species from King Edward Cove on South Georgia Island. They described the apothecia as small, concave with incurved margins, and reported a faint violet colouring of the epithecium in K. We have macroscopically studied the type material from BM, and confirmed the thin thallus and the sessile, concave apothecia with prominent incurved margins. As there are no molecular data to justify inclusion in *Hueidea*, and even indication in the protologue and from Øvstedal & Smith (2001) that the species may produce *sedifolia*-grey, we see no reason to include *H. diphyella* in *Hueidea* pending molecular evidence.

*Huea imponens* (Stizenb.) C.W. Dodge (Southern Africa: South Africa)

*Huea lactescens* (Leight.) C.W. Dodge (South Atlantic Ocean: St. Helena)

*Huea leptospora* (Zahlbr.) C.W. Dodge (Southwest Africa: Namibia)

*Huea maurula* (Müll. Arg.) C.W. Dodge (East Africa: Ethiopia)

*Huea obliquans* (Nyl.) C.W. Dodge (Indian Ocean: Mauritius: Rodriques Island)

*Huea polioterodes* (J. Steiner) C.W. Dodge (Southeast Africa: Kenya)

*Huea punicae* (Vain.) C.W. Dodge (Southern Africa: South Africa)

*Huea seductrix* (Stizenb.) C.W. Dodge (Southern Africa: South Africa)

*Huea smaragdula* C.W. Dodge

**NOTES**. – Shown by Castello and Nimis (1995) to be a synonym of *Carbonea capsulata* (C.W. Dodge & G.E. Baker) Hale.

*Huea stuhlmannii* (Müll. Arg.) C.W. Dodge (Southeast Africa: Tanzania)

*Huea suspicax* (Stizenb.) C.W. Dodge (East Africa: Ethiopia)

*Huea variabilis* (Müll. Arg.) C.W. Dodge (Arabian Sea: Yemen: Socotra)

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## APPENDIX I: MOLECULAR VOUCHER METADATA

**Table 1.** Sequences used in the molecular phylogenetic analyses for this study including the identification (taxonomy following Figure 2 herein), country of collection, collector and collector's number, herbarium deposited and GenBank accession numbers. The sequences newly produced for this study are in bold text.

| Taxon | Locality | Voucher | Herbarium | rnITS | rnLSU | mrSSU |
|---|---|---|---|---|---|---|
| *Blastenia ammiospila* | Austria | Søchting 9345 | C | KC179413 | - | KC179491 |
| *Blastenia ammiospila* | Norway | Søchting 10092 | C | - | KC179161 | - |
| *Blastenia catalinae* | Sweden | Arup L06075 | LD | FJ866792 | KT291532 | KT291477 |
| *Blastenia crenularia* | Iceland | Søchting 7523 | C | KC179415 | KC179162 | KC179492 |
| *Bryoplaca jungermanniae* | Greenland | Søchting 10451 | C | KC179420 | MT952895 | MT95295 |
| *Bryoplaca sinapisperma* | Norway | Arup L08184 | LD | KC179421 | - | KC179495 |
| *Bryoplaca sinapisperma* | Norway | Arup L08184 | LD | - | MT952896 | - |
| *Bryoplaca tetraspora* | Antarctica | Søchting 7979 | C | KC179422 | - | - |
| *Bryoplaca tetraspora* | Greenland | Søchting 10480 | C | - | MT952897 | KC179496 |
| *Caloplaca cerina* | Norway | Elvebakk 03:109 | TROM | KC179425 | KC179168 | KC179499 |
| *Caloplaca chlorina* | Denmark | Søchting 7321 | C | KC179426 | KC179169 | KC179500 |
| *Caloplaca turkuensis* | Sweden | Frödén 1909 | LD | KC179432 | MT952899 | KC179501 |
| *Eilifdahlia dahlii* | Australia | Kärnefelt 20043101 | LD | KJ021318 | KJ021253 | KJ021279 |
| *Eilifdalia wirthii* | Australia | Wirth et al. 05.10.2011 | STU | KJ021320 | KJH021255 | KJ021281 |
| *Fauriea chujaensis* | South Korea | Kondratyuk s.n. | KoLRI | KX793095 | KX793098 | KX793101 |
| *Fauriea orientochinensis* | China | Wang & Hur s.n. | KoLRI | KX793096 | KX793099 | KX793102 |
| *Franwilsia kilcundaensis* | Australia | Kärnefelt 20047101 | LD | KJ021327 | KJ021260 | KJ021287 |
| *Franwilsia bastowii* | Australia | Kärnefelt 994301 | LD | KJ021324 | KJ021257 | KJ021284 |
| *Gintarasiella aggregata* | Australia | Kantvilas 476/12 | HO | KY614392 | KY614450 | - |
| *Gyalolechia aurea* | Austria | Arup L97493 | LD | KC179434 | - | KC179530 |
| *Gyalolechia aurea* | Austria | Poelt & Grube s.n. | GZU | - | KC179196 | - |
| *Gyalolechia flavorubescens* | Estonia | Søchting 10127 | C | KC179439 | KC179197 | KC179531 |
| *Gyalolechia flavovirescens* | Russia | Søchting 8648 | C | AF353966 | KC179198 | KC179532 |
| *Gyalolechia fulgens* | Spain | Søchting 7306 | C | KC179440 | - | - |
| *Gyalolechia fulgens* | Sweden | Arup L06206 | LD | - | KC179199 | - |
| *Gyalolechia fulgens* | Sweden | Søchting 10586 | C | - | - | KC179533 |
| *Hueidea austroaquatica* | Kerguelen | Ertz 19067 | BR | **PQ137203** | **PQ137195** | **PQ137197** |
| *Huidea australiensis* | Australia | McCarthy 1807 | HO | **PQ137204** | - | - |
| *Huidea australiensis* | Australia | McCarthy 1807 | CANB | - | - | **PQ137198** |
| *Hueidea cerussata* | Antarctica | Søchting 7628 | C | **PQ137205** | - | **PQ137199** |
| *Hueidea coeruleofrigida* | Antarctica | Seppelt 19864 | C | **PQ137206** | - | **PQ137200** |
| *Hueidea coeruleofrigida* | Antarctica | Castello s.n. | TSB | **PQ137207** | - | - |
| *Hueidea grisea* | Antarctica | Søchting 7845 | C | **PQ137208** | - | **PQ137201** |
| *Hueidea grisea* | Antarctica | Søchting 7627 | C | - | **PQ137196** | **PQ137202** |
| *Huneckia pollinii* | USA | Morse 14464 | LD | KJ021336 | KJ021265 | KJ021296 |
| *Huneckia wrightii* | Ecuador | Aptroot 63246 | CDS | MT967388 | - | - |
| *Huneckia wrightii* | Ecuador | Miranda 962 | CDS | - | MT952903 | MT952929 |

**Table 1 (continued).** Sequences used in the molecular phylogenetic analyses for this study including the identification (taxonomy following Figure 2 herein), country of collection, collector and collector's number, herbarium deposited and GenBank accession numbers. The sequences newly produced for this study are in bold text.

| Taxon | Locality | Voucher | Herbarium | rnITS | rnLSU | mrSSU |
|---|---|---|---|---|---|---|
| *Jasonhuria bogilana* | South Korea | unknown | KoLRI | KT220196 | KT220205 | KT220214 |
| *Lacrima epiphora* | Panama | van den Boom 43698 | hb. vd Boom | MT967392 | MT952904 | MT952930 |
| *Lacrima galapagoensis* | Ecuador | Bungartz 4091 | CDS | MT967297 | - | - |
| *Lacrima galapagoensis* | Ecuador | Ertz 22855 | CDS | - | MT952905 | MT952931 |
| *Leproplaca chrysodeta* | Sweden | Arup L07107 | LD | KC179448 | KC179206 | MT952933 |
| *Leproplaca chrysodeta* | Sweden | Arup L13261 | LD | - | - | MT952933 |
| *Leproplaca xantholyta* | Austria | Arup L97278 | LD | KC179451 | KC179208 | KC179542 |
| *Leproplaca xantholyta* | Spain | Søchting 9675 | C | - | KC179208 | KC179542 |
| *Kuettlingeria atroflava* | Sweden | Arup L06010 | LD | KC179424 | KC179171 | KC179504 |
| *Kuettlingeria albolutescens* | Sweden | Arup L09030 | LD | KC179423 | MT952998 | KC179502 |
| *Kuettlingeria erythrocarpa* | Italy | Arup L07109 | LD | KC179427 | KC179173 | KC179506 |
| *Kuettlingeria teicholyta* | Denmark | Søchting 11195 | C | KC179431 | KC179176 | - |
| *Kuettlingeria teicholyta* | Denmark | Søchting 9772 | C | - | - | KC179510 |
| *Lendemeriella reptans* | USA | Lendemer 48186 | NY | MH104934 | MH100766 | MH100796 |
| *Loekoesia austrocoreana* | South Korea | unknown | KoLRI | KT220220 | KT220210 | KT220219 |
| *Loekoesia yuchiorum* | USA | Lendemer 22026 | LD | OQ678329 | OQ678282 | OQ678286 |
| *Marchantiana asserigena* | Scotland | Arup L10184 | LD | MT967307 | MT952907 | MT952934 |
| *Marchantiana epibrya* | Tasmania | Kantvilas 95/12 | C | OQ678331 | OQ678283 | OQ678287 |
| *Marchantiana michelagoensis* | Australia | Elix 37402 | LD | OQ678334 | - | OQ678288 |
| *Marchantiana occidentalis* | Australia | Kärnefelt 20042502 | LD | MT964708 | - | KJ021304 |
| *Marchantiana queenslandica* | Australia | Kalb 27764 | CANB | MT967409 | MT952908 | - |
| *Marchantiana ramulicola* | Chile | Søchting 12308 | C | OQ678350 | - | OQ678289 |
| *Marchantiana subpyracea* | New Zealand | Frödén 1317 | LD | OQ678351 | OQ678284 | OQ678290 |
| *Oceanoplaca catillarioides* | Cape Verde | van den Boom 36365 | LD | MT967410 | MT952909 | MT952935 |
| *Oceanoplaca caesiosorediata* | Cape Verde | van den Boom 36346 | LD | MT967412 | MT952911 | MT952936 |
| *Oceanoplaca isidiosa* | Ecuador | Adsersen LAM8-1 | C | MT967416 | MT952913 | MT952938 |
| *Obscuroplaca camptidia* | USA | Morse 14420 | LD | MT967431 | MT952918 | MT952942 |
| *Obscuroplaca ochrolechioides* | Australia | Kalb & Rogers 18982 | CANB | MT967432 | MT952919 | - |
| *Obscuroplaca tortuca* | Ecuador | Aptroot 65189 | CDS | MT967433 | - | MT952943 |
| *Olegblumia demissa* | Italy | Arup L97911 | LD | AF353960 | KC179172 | KC179505 |
| *Pyrenodesmia alociza* | Sweden | Arup L10185 | LD | MT967436 | MT952920 | MT952944 |
| *Pyrenodesmia chalybaea* | Austria | Søchting 9351 | C | KC179454 | MT952921 | KC179571 |
| *Pyrenodesmia variabilis* | Austria | Arup s.n. | LD | AF353963 | - | - |
| *Pyrenodesmia variabilis* | Sweden | Arup L03134 | LD | - | KC179234 | KC179572 |
| *Rufoplaca scotoplaca* | Sweden | Arup L10032 | LD | KC179457 | KC179235 | KC179573 |
| *Rufoplaca* sp. | USA | Arup L09201 | LD | KC179458 | KC179236 | KC179574 |

**Table 1 (continued).** Sequences used in the molecular phylogenetic analyses for this study including the identification (taxonomy following Figure 2 herein), country of collection, collector and collector's number, herbarium deposited and GenBank accession numbers. The sequences newly produced for this study are in bold text.

| Taxon | Locality | Voucher | Herbarium | rnITS | rnLSU | mrSSU |
|---|---|---|---|---|---|---|
| *Rufoplaca tristiuscula* | Norway | Arup L08171 | LD | KC179460 | KC179237 | KC179575 |
| *Sanguinodiscus aractinus* | Czech Republic | Vondrák 6702 | PRA | MH104919 | - | MH100773 |
| *Sanguinodiscus haematites* | Ukraine | Vondrák 7278 | PRA | MH104928 | MH100789 | MH100756 |
| *Seirophora blumii* | Iran | Haji Moniri Al_4 | KW | KT456219 | KT456234 | KT456249 |
| *Seirophora scorigena* | Spain | Snogerup & Snogerup 17201 | LD | KC179466 | KC179244 | KC179583 |
| *Seirophora villosa* | Morocco | Guttova s.n. | KW-L | KY614436 | KY614469 | KY614511 |
| *Sucioplaca diplacia* | Ecuador | Ertz 11610 | CDS | MT967470 | MT952922 | MT952945 |
| *Upretia amarkantakana* | India | unknown | LWG | MG652764 | - | MG652767 |
| *Upretia squamulosa* | China | Wang et al. 17-56088 | KUN | MH497054 | - | - |
| *Upretia squamulosa* | China | Wang et al. 16-50174 | KUN | - | MH497052 | - |
| *Usnochroma carphinea* | France | Roux s.n. | C | KC179468 | KC179259 | KC179598 |
| *Usnochroma scoriophila* | Spain | Gomez-Bolea s.n. | C | KC179469 | KC179260 | KC179599 |
| *Variospora aurantia* | Spain | Llimona s.n. | C | KC179470 | - | KC179600 |
| *Variospora aurantia* | Italy | Lange s.n. | C | - | KC179261 | - |
| *Variospora dolomiticola* | Spain | Thell SP0514 | LD | KC179471 | KC179262 | KC179601 |
| *Variospora flavescens* | Denmark | Søchting 9601 | C | KC179473 | - | - |
| *Variospora flavescens* | Sweden | Arup L03060 | LD | - | KC179263 | KC179602 |
| *Variospora glomerata* | Sweden | Arup L03119 | LD | KC179474 | KC179264 | KC179603 |
| *Variospora thallincola* | Sweden | Søchting 7481 | C | KC179475 | - | - |
| *Variospora thallincola* | Sweden | Gaya et al. s.n. | BCN | - | JQ301563 | - |
| *Variospora thallincola* | United Kingdom | Arup L92148 | LD | - | - | KC179604 |
| *Variospora velana* | Italy | Arup L07194 | LD | KC179476 | - | - |
| *Variospora velana* | Italy | Arup L07123 | LD | - | KC179265 | KC179605 |
| *Yoshimuria galbina* | South Korea | Arup L15370 | LD | MT967482 | - | - |
| *Yoshimuria galbina* | South Korea | Arup 15500 | LD | - | MT952923 | MT952946 |
| *Yoshimuria spodoplaca* | South Korea | Wang & Ryu 110364 | KoLRI | KJ021249 | - | KJ023194 |
| *Yoshimuria spodoplaca* | South Korea | Arup L15575 | LD | - | MT952924 | - |

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# A new combination for *Parmelia protosignifera*, an overlooked species of *Notoparmelia*

GINTARAS KANTVILAS[1]

ABSTRACT. – The new combination *Notoparmelia protosignifera* is proposed for *Parmelia protosignifera*. The species is illustrated and discussed briefly.

KEYWORDS. – Australia, biodiversity, lichens, *Parmelia*, Parmeliaceae, Tasmania.

## INTRODUCTION

*Notoparmelia* A. Crespo, Ferencova & Divakar is a recent segregate of the large genus *Parmelia* Ach., a group which was, historically, the repository for almost all foliose lichens, but which has been progressively refined and revised over the last two centuries. The changes to the delimitation of *Parmelia* were based initially purely on morphology, then with the addition of anatomical and chemical features, and, most recently, on the basis of DNA-sequence data. *Notoparmelia* comprises a group of essentially Australasian species. It was recognised as a distinct lineage within *Parmelia* sensu stricto by Crespo et al. (2010), and then segregated formally by Ferencova et al. (2014) on the basis of additional micromorphological and anatomical characters, chiefly pertaining to the exciple and ascospores. The salient features of *Notoparmelia* are the foliose, grey thallus (due to cortical atranorin), with well-developed lobes with marginal and/or laminal, elongate pseudocyphellae, and the black lower surface with abundant rhizines. These features are shared with *Parmelia* sensu stricto, from which *Notoparmelia* differs by having generally larger apothecia with a radially split disc, an unstratified proper exciple, and somewhat smaller ascospores with thinner walls ≤ 1 µm thick (Ferencova et al. 2014). These differences are not clear-cut, however, and the recognition of the genus rests strongly on molecular data.

When Ferencova et al. (2014) described the genus, they also made the necessary new combinations for 16 of the species but, inexplicably, overlooked or omitted *Parmelia protosignifer*a Elix & J.Johnst., a widespread Australasian endemic (McCarthy 2023). This has caused difficulties for the compilation regional checklists (McCarthy 2023) and, most recently, the writing of the new *Tasmanian Lichen Flora* (https://flora.tmag.tas.gov.au/about/lichens/). The species has been studied in some detail, leaving no doubt that it belongs in *Notoparmelia*, and so the necessary new combination is introduced here.

## MATERIALS AND METHODS

Comparative observations of the species studied is based on the extensive collections of Parmeliaceae held in the Tasmanian Herbarium (HO), type material held in the Australian National Herbarium (CANB) and the National Herbarium of Victoria (MEL), and literature sources as cited. Ascospore measurements are presented in the format smallest measurement–*mean*–largest measurement, with *n* signifying the number of observations.

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**Figure 1.** *Notoparmelia protosignifera* habit, showing grey, foliose lobes with a network of white pseudocyphellae (*Kantvilas 1136/01*, HO); inset showing apothecium (*Moscal 11044 p.p.*, HO). Scales = 5 mm. Photos from J. Jarman.

## RESULTS AND DISCUSSION

With its extensive, loosely to tightly adnate foliose thallus lacking soredia and isidia, composed of irregular, imbricate, plane, undulate or concave lobes, (1.5–)2–12 mm wide, a pale grey to pale greenish grey upper surface with abundant, fleck-like, linear or effigurate, laminal pseudocyphellae that sometimes develop into a conspicuous white network, and abundant, simple to squarrose rhizines, *Parmelia protosignifera* (Figure 1) is morphologically identical to *N. signifera* (Nyl.) A. Crespo, Ferencová & Divakar, the type species of *Notoparmelia*. It also displays the critical features that characterise the genus (Ferencova et al. 2014), notably, the relatively large, often radially lacerate apothecia, an unstratified exciple and broadly ellipsoid ascospores, 12–*14.9*–17 × 8–*9.3*–11 µm (*n*=50), with the wall 0.6–0.8(–1) µm thick. It differs from *N. signifera* unequivocally by its chemical composition, which consists of atranorin, chloroatranorin and protocetraric acid (medulla K± reddish brown, KC–, C–, P+ red, UV–). In contrast, *N. signifera* contains atranorin, chloroatranorin, salazinic acid, consalazinic acid (minor) and lobaric acid (± minor) (medulla K+ yellow→red, KC–, C–, P+ orange-red, UV–). Further descriptive data are provided by Elix & Johnston (1988) and Elix (1994).

Based on the morphological similarities between *Parmelia protosignifera* and *N. signifera*, as well as the fact that *P. protosignifera* possesses the morphological characters that distinguish *Notoparmelia* from other genera, it is clear that *P. protosignifera* belongs to *Notoparmelia*. The necessary combination is provided below. With the transfer of this taxon to *Notoparmelia*, all but one of the Australian and Tasmanian species treated as *Parmelia* by Elix (1994) and Kantvilas et al. (2002) are now transferred to *Notoparmelia*. The single exception remaining in *Parmelia* sensu stricto is the cosmopolitan *P. sulcata* Taylor (McCarthy 2023). In New Zealand, *P. saxatilis* (L.) Ach. is also present (Galloway 2007).

*Notoparmelia protosignifera* is widely scattered on rocks, mostly in highland or locally moister habitats in Tasmania, the south-eastern Australian mainland (Victoria, New South Wales and the Australian Capital Territory) and New Zealand (McCarthy 2023). Its habitat is essentially identical to that of *N.*

*signifera*, although it is far less common (G. Kantvilas, unpublished data). Whilst the two species are essentially indistinguishable morphologically, the lobes of *N. protosignifera* are generally a little less leathery and less frequently discoloured dark grey or blackish. The two species can be sympatric and are best distinguished by means of a K-test.

## TAXONOMIC SECTION

**Notoparmelia protosignifera** (Elix & J.Johnst.) Kantvilas, comb. nov.
MycoBank# MB856134.

≡ *Parmelia protosignifera* Elix & J.Johnst., Mycotaxon 31: 493. 1988. **TYPE: AUSTRALIA.** NEW SOUTH WALES: eastern slopes of Tinderry Peak, 12 km E of Michelago, 35°42'S 149°16'E, 1338 m, on sheltered granite rock ledge, 8.xii.1977, *J.A. Elix 4051* (CANB!, holotype; MEL!, isotype).


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# *Clypeoria*, a new genus, with clypeate hyphophores separated from *Gyalideopsis* s. lat. (Gomphillaceae, lichenized Ascomycota)

KENTO MIYAZAWA[1]* AND YOSHIHITO OHMURA[2,3]

ABSTRACT. – A new genus *Clypeoria*, including two newly combined species (*C. japonica* and *C. lambinonii*), is proposed, that is segregated from *Gyalideopsis* s. lat. This genus is characterized by the presence of clypeate hyphophores with a central reduced stipe on the underside, moniliform diahyphae with droplet-shaped cells at the terminal segments, and adnate ascomata. Among the polyphyletic assemblage corresponding to *Gyalideopsis* s. lat., *Clypeoria* is distinguished from *G. peruviana*, the type species of the genus, which is characterized by sessile apothecia with a well-developed exciple and the absence of hyphophores. *Gyalideopsis peruviana* is presently included in the *G. africana* group, the other members of which differ from *Clypeoria* by the production of setiform-capitate hyphophores and musicolous habit. Both *C. japonica* and *C. lambinonii* were previously treated in the *G. palmata* group, due to the presence of flabelliform and corticolous habit. However, in analysis of mtSSU and nuLSU sequence data, *C. japonica* was recovered in a large clade including the ecologically distinct foliicolous genera *Arthotheliopsis*, *Psathyromyces*, *Sipmanidea*, and *Verruciplaca*, which also produce adnate and spot-like apothecia but differ in producing yellow-orange apothecia and/or different hyphophore types. For its part, the *G. palmata* group appears to be heterogeneous, including various types of apothecia and hyphophores. The remaining species in the *G. palmata* group should be revised through future taxonomic research.

KEYWORDS. – Ascomata, conidiomata, corticolous, Japan, nuITS, nuLSU, mtSSU, phylogeny, *RPB2*.

## INTRODUCTION

The genus *Gyalideopsis* Vězda, one of the largest genera within Gomphillaceae, contains species primarily with adnate to stipitate, biatorine or lecideine apothecia, and squamiform to stipitate hyphophores (Lücking et al. 2005, 2006). It was originally described by Vězda (1972) to accommodate four species and has grown to include to approximately 100 species, distributed mainly in tropical regions, with some species in temperate to boreal areas (Harada & Kawakami 2011, Holien & Tønsberg 1996, Lendemer & Lücking 2004, Lücking et al. 2007, Xavier-Leite et al. 2018). The genus has a wide ecological amplitude, being found on nearly all the substrata that lichens are known to occur (Lücking et al. 2005, 2006).

The morphological heterogeneity of *Gyalideopsis*, especially regarding the apothecia and hyphophores, has long been recognized, and has led to the establishment of segregate genera, including

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*Diploschistella* Vain., *Ferraroa* Lücking, Sérus. & Vězda, *Jamesiella* Lücking, Sérus. & Vězda, and *Lithogyalideopsis* Lücking, Sérus. & Vězda (Lücking et al. 2005). The remaining species of *Gyalideopsis* s. lat. have been divided into several groups, suggesting the necessity of additional investigation using molecular techniques (Lücking et al. 2005). In recent molecular studies by Xavier-Leite et al. (2022, 2023), two new genera, *Adelphomyces* Xavier-Leite, M. Cáceres & Lücking and *Vezdamyces* Xavier-Leite, M. Cáceres & Lücking, were separated from *Gyalideopsis* s. lat. These studies support the hypothesis that hyphophore types in Gomphillaceae reflect evolutionary relationships among related species (Xavier-Leite et al. 2022). However, the analysis included only a few species of *Gyalideopsis* s. lat., highlighting the need for a more detailed investigation, focusing particularly on the morphological characteristics of the hyphophores.

Within *Gyalideopsis*, there is one subgroup characterized by a distinctive clypeate (i.e., round shield-shaped) hyphophores, with an extremely reduced central stipe (Harada & Vězda 2000, Lücking et al. 2005, Vězda 1979). There are two species with this distinctive clypeate hyphophore morphology: *G. japonica* H. Harada & Vězda and *G. lambinonii* Vězda (Harada & Vězda 2000, Vězda 1979). Cladistic analyses based on phenotypic data have already suggested that these two species form a monophyletic group (Lücking et al. 2005), emphasizing the importance of re-evaluating their taxonomic placement through molecular phylogenetic analyses.

In this study, we examined the placement of these two species based on morphological and chemical data and DNA sequence data obtained from *G. japonica*. As a result, we propose the establishment of a new genus, *Clypeoria*, to accommodate these species, which are distinct from *Gyalideopsis*.

## Materials and Methods

**Morphology and chemistry**. – To examine the morphological and chemical characters uniting *Gyalideopsis japonica* and *G. lambinonii*, as well as to compare them with the type species of *Gyalideopsis*, *G. peruviana*, morphological observations and chemical analyses were conducted on the following specimens: eight specimens of *G. japonica* collected by us in Japan and exsiccati of *G. lambinonii* (Kalb, *Lich. Neotrop. 64*, TNS) and *G. peruviana* G. Merr. ex Vězda (Kalb, *Lich. Neotrop. 462*, TNS).

Morphological observations and photography were performed using a dissecting microscope (SZX16; Olympus, Tokyo, Japan) and a differential interference contrast microscope (BX51; Olympus) with a digital camera (EOS Kiss X10i; Canon, Tokyo, Japan). Anatomical examinations were performed using hand-cut sections mounted in GAW (glycerin: ethanol: water = 1: 1: 1) solution (Asahina 1936).

Secondary substances were analyzed using a high-performance thin layer chromatography (HPTLC) following Schumm and Elix (2015). The solvent system B′ (n-hexane: methyl tert-butyl ether: formic acid, 140: 72: 18) (Culberson & Johnson 1982) was used for HPTLC. The spot color was checked under 254 and 366 nm wavelength of UV and visible light, before and after spraying with 10% sulfuric acid on the HPTLC plate and charring at 90°C for 20 minutes.

**DNA extraction, PCR amplification and sequencing.** – DNA was extracted from fresh material collected within three years according to a modified method of Izumitsu et al. (2012) (see also Miyazawa et al. 2022) or a modified CTAB protocol (Hosaka 2009). The voucher specimens for DNA extractions are housed in TNS (Table 1).

For PCR amplification, 10 µL of PCR mix contained 1 µL genomic DNA extraction, 0.25 µL of each primer (10 pmol/µL) and 5 µL EmeraldAmp® MAX PCR Master Mix (TaKaRa Bio Inc.). The partial sequences of the internal transcribed spacer and the large subunit of the nuclear ribosomal RNA gene (nuITS and nuLSU), the small subunit of the mitochondrial ribosomal RNA gene (mtSSU), and the RNA polymerase II gene (*RPB2*) were amplified with the primer sets ITS1F (Gardes & Bruns 1993) and LR1 (Vilgalys & Hester 1990) for nuITS, LIC24R (Miadlikowska & Lutzoni 2000) and LR7 or LR3 (Vilgalys & Hester 1990) for nuLSU, mrSSU1 and mrSSU3R (Zoller et al. 1999) for mtSSU, and fRPB2-5F and fRPB2-7cR (Liu et al. 1999) for *RPB2*. The PCR conditions followed the methods of Ohmura et al. (2006) for nuITS, that of Miyazawa and Ohmura (2023a) for nuLSU, and that of Miyazawa and Ohmura (2023b) for mtSSU. The PCR conditions for *RPB2* were as follows: initial denaturation at 94°C for 2 minutes; followed by 35 cycles of denaturation at 94°C for 20 seconds, annealing at 52°C for 1 minute, and extension at 72°C for 2 minutes; and a final extension at 72°C for 15 minutes.

**Table 1.** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis (Fig. 3). New sequences obtained in this study are in bold.

| Taxon | Country; voucher | mtSSU | nuLSU | Reference |
|---|---|---|---|---|
| *Arthotheliopsis trichariodes* | Brazil; *A. Xavier-Leite 1924* (ISE) | MZ827202 | MZ851505 | Xavier-Leite et al. (2022) |
| *Bezerroplaca lucernifera* | Costa Rica; *R. Lücking s.n.* (F) | AY341370 | AY341356 | Lücking et al. (2004) |
| *Clypeoria japonica* | Japan; *K. Miyazawa 1036* (TNS) | **LC834121** | **LC834127** | This study |
| *C. japonica* | Japan; *M. Chaki 79* (TNS) | **LC834122** | **LC834128** | This study |
| *C. japonica* | Japan; *M. Chaki 84* (TNS) | **LC834123** | **LC834129** | This study |
| *C. japonica* | Japan; *M. Chaki 191* (TNS) | **LC834124** | **LC834130** | This study |
| *C. japonica* | Japan; *M. Chaki 420* (TNS) | **LC834125** | **LC834131** | This study |
| *C. japonica* | Japan; *Y. Ohmura 14150* (TNS) | **LC834126** | **LC834132** | This study |
| *Echinoplaca campanulata* | Brazil; *M. Cáceres & R. Lücking 167* (B, URM) | MZ827250 | MZ851703 | Xavier-Leite et al. (2022) |
| *E. epiphylla* | Brazil; *M. Cáceres & R. Lücking 165a* (B, URM) | MZ827245 | MZ851707 | Xavier-Leite et al. (2022) |
| *E. epiphylla* | Mexico; *M.A. Herrera-Campos et al. s.n.* (F) | AY341368 | AY341354 | Lücking et al. (2004) |
| *E. epiphylla* | Brazil; *A. Xavier-Leite & M. Cáceres 1736* (ISE) | MZ827191 | MZ851604 | Xavier-Leite et al. (2022) |
| *E.* aff. *epiphylla*-1 | Brazil; *A. Xavier-Leite 1933* (ISE) | MZ827267 | MZ851509 | Xavier-Leite et al. (2022) |
| *Gomphillus americanus* | U.S.A.; *J. Lendemer 45954* (NY) | KY353115 | KY381580 | Unpublished |
| *G. calycioides* | U.S.A.; *J. Lendemer 46470* (NY) | MK318271 | MH887485 | Unpublished, Anderson-Stewart et al. (2018) |
| *G. calycioides* | U.K.; *T. Lumbsch 20100d* (F) | KF833341 | KF833329 | Unpublished |

| Taxon | Country; voucher | mtSSU | nuLSU | Reference |
|---|---|---|---|---|
| *G. hyalinus (G. ophiosporus)* | Costa Rica; *S. Will-Wolf 10006a* (F) | AY341371 | AY341357 | Lücking et al. (2004) |
| *Gyalideopsis* sp. | Costa Rica; *M.P. Nelsen 2066a* (F) | AY341373 | AY341359 | Lücking et al. (2004) |
| *Psathyromyces heterellus* | Brazil; *M. Cáceres & A. Aptroot 28673* (ISE) | MZ827302 | MZ851679 | Xavier-Leite et al. (2022) |
| *P. heterellus* | Brazil; *M. Caceres & A. Aptroot 28675* (ISE) | MZ827285 | MZ851680 | Xavier-Leite et al. (2022) |
| *P. heterellus* | Brazil; *A. Xavier-Leite et al. 2799* (ISE) | MZ827221 | MZ851643 | Xavier-Leite et al. (2022) |
| *P. heterellus* | Brazil; *M. Caceres & A. Aptroot 11953* (ISE) | KF833342 | KF833330 | Unpublished |
| *P. heterellus* | Brazil; *A. Xavier-Leite 1977* (ISE) | MZ827198 | MZ851523 | Xavier-Leite et al. (2022) |
| *P. heterellus* | Brazil; *A. Xavier-Leite 1989* (ISE) | MZ827183 | MZ851533 | Xavier-Leite et al. (2022) |
| *P. heterellus* | Brazil; *A. Xavier-Leite 2533* (ISE) | MZ827206 | MZ851561 | Xavier-Leite et al. (2022) |
| *Sipmanidea neotropica* | Brazil; *A. Xavier-Leite 1927* (ISE) | MZ827201 | MZ851507 | Xavier-Leite et al. (2022) |
| *Sporocybomyces leucotrichoides* | Costa Rica; *R. Lücking s.n.* (F) | AY341369 | AY341355 | Lücking et al. (2004) |
| *S. leucotrichoides* | Brazil; *A. Xavier-Leite et al. 1027* (ISE) | MZ827268 | MZ851609 | Xavier-Leite et al. (2022) |
| *S. leucotrichoides* | Brazil; *A. Xavier-Leite 1989* (ISE) | MZ827184 | MZ851534 | Xavier-Leite et al. (2022) |
| *Verruciplaca calcarea* | Brazil; *A. Xavier-Leite et al. 1262c* (ISE) | MZ827233 | MZ851652 | Xavier-Leite et al. (2022) |
| *V. verrucifera* | Brazil; *A. Xavier-Leite 1955* (ISE) | MZ827169 | MZ851517 | Xavier-Leite et al. (2022) |
| *V. verrucifera* | Brazil; *A. Xavier-Leite 2541* (ISE) | MZ827195 | MZ851563 | Xavier-Leite et al. (2022) |
| *V. verrucifera* | Brazil; *A. Xavier-Leite 2545* (ISE) | MZ827196 | MZ851564 | Xavier-Leite et al. (2022) |

| Taxon | Country; voucher | mtSSU | nuLSU | Reference |
|---|---|---|---|---|
| *Verruciplaca sp.* | Brazil; *A. Xavier-Leite & M. Cáceres 1718* (ISE) | MZ827271 | MZ851602 | Xavier-Leite et al. (2022) |

The PCR products were purified with the method of Miyazawa and Ohmura (2023a). DNA sequencing was performed on an Applied Biosystems™ 3500xL Genetic Analyzer (Thermo Fisher Scientific) using the BigDye® Terminator v3.1 Cycle Sequencing Kit (Thermo Fisher Scientific) following the manufacturer's instructions.

**MOLECULAR PHYLOGENETIC ANALYSES.** – The newly obtained mtSSU and nuLSU sequences of *Gyalideopsis japonica* from Japanese material were checked through BLAST searches to make sure they were from the target taxa (not contaminants) and of high quality. The checked sequences were aligned with those of selected taxa in Gomphillaceae from GenBank (Table 1) in MAFFT ver. 7 (Katoh et al. 2019) with default settings. The sequences of taxa included in the alignment, as well as those of *Echinoplaca* spp. as the outgroup (Table 1), were selected according to the BLAST results in GenBank and previous phylogenetic studies (Xavier-Leite et al. 2022). BLAST results suggested the sequences of *Gyalideopsis japonica* had the highest similarity with *Psathyromyces heterellus* (Stirt.) Xavier-Leite, M. Cáceres & Lücking (as *Aderkomyces heterellus* (Stirt.) Lücking, Sérus. & Vězda; approximately 95% for mtSSU and approximately 97% for nuLSU). Additionally, based on the previously published phylogenetic studies using the same loci (Xavier-Leite et al. 2022), our data show that *G. japonica* is included in a clade nested deeper than *Echinoplaca* s. str. and *Sporocybomyces* (as the *E. leucotrichoides* clade). Samples that were analyzed by Xavier-Leite et al. (2022), but which lacked data for both mtSSU and nuLSU were excluded to minimize the data gaps in our analyses.

Due to the limited number of reference sequences for nuITS and *RPB2* in GenBank, our sequences obtained for these regions were not used for molecular phylogenetic analysis. However, we provide them here for future research. Each single locus data set (mtSSU and nuLSU) was separately aligned. After removing sites with gaps, or missing or ambiguous data, initial phylogenetic trees were reconstructed based on each single locus using the Neighbor-Joining method (Saitou & Nei 1987). This initial analysis allowed us to check for any potential conflicts prior to concatenation for a comprehensive phylogenetic analysis. Once it was confirmed that no significant conflicts were observed, the data sets were concatenated. The final alignment of 1099 sites was used for the molecular phylogenetic analyses.

Maximum likelihood (ML) analyses were performed using the General Time Reversible model (Nei & Kumar 2000) plus gamma distribution with invariant sites (G + I), which was selected as the best fitting model based on the lowest Bayesian information criterion score. The bootstrap values (≥70%) of 1,000 replicates for NJ and ML are shown on each branch. All calculations were conducted in MEGA X (Kumar et al. 2018).

## RESULTS AND DISCUSSION

**MORPHOLOGY AND CHEMISTRY**. – Based on the examination of our collections and exsiccati, two closely related taxa, currently recognized as *Gyalideopsis japonica* and *G. lambinonii* (see Harada & Vězda 2000), were confirmed to belong to *Gyalideopsis* s. lat. They share the distinct shape of clypeate hyphophores producing numerous diahyphae (Fig. 1) but these differ from each other in their apothecial morphology. The apothecial margin of *G. lambinonii* was distinct (Fig. 2C), due to the slightly raised excipulum from the thallus (Fig. 2D), whereas that of *G. japonica* was indistinct and widely spread over the thallus (Fig. 2A), due to the excipulum not being raised from the thallus (Fig. 2B). This observation is consistent with Harada and Vězda (2000).

This group, consisting of *G. japonica* and *G. lambinonii* was clearly different from *G. peruviana*. which is the type species of the genus *Gyalideopsis*. The *G. japonica-G. lambinonii* group has adnate apothecia (Figs. 1A & B, 2A & C), monosporous asci (in Vězda 1979: fig. 6.16), and clypeate hyphophores (Figs. 1A–D), while *G. peruviana* has sessile apothecia with a well-developed exciple (Figs. 2E & F), 6–8 ascospores per ascus (Fig. 2F), and no hyphophores. Our observations were consistent with previous

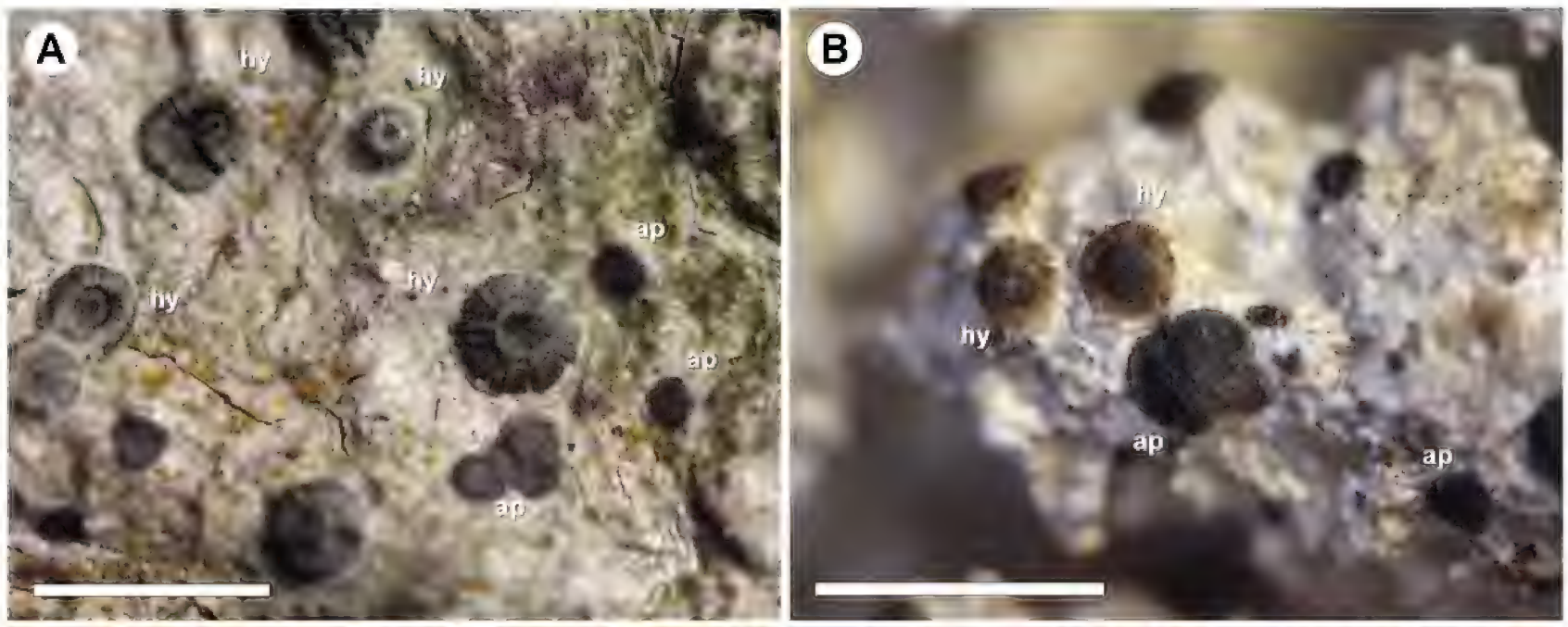


**Figure 1.** Morphology of *Clypeoria japonica* and *C. lambinonii*. **A**, *C. japonica* (*K. Miyazawa 1036*, TNS); **C & E**, *C. japonica*. (*M. Chaki 79*, TNS); **B, D & F**, *C. lambinonii* (*K. Kalb s.n.* [Kalb, Lich. Neotrop. 64. as *Gyalideopsis lambinonii* Vězda], TNS). A & B, thallus with apothecia (ap) and hyphophores (hy); C & D, a mashed hyphophore with diahyphae from each taxon; E & F, moniliform diahyphae. Scales = 1 mm in A & B, 50 µm in C & D, 20 µm in E & F.

reports of this species (Lücking et al. 2005, Vězda 1972). Additionally, the *G. africana* group, to which *G. peruviana* is considered to belong (Lücking et al. 2005), is characterized by setiform-capitate hyphophores, which clearly differ from those of the *G. japonica-G. lambinonii* group. In addition, members of the *G. africana* are typically musicolous (Lücking et al. 2005), while *G. japonica* and *G. lambinonii* are corticolous (Harada & Vězda 2000, Vězda 1979).

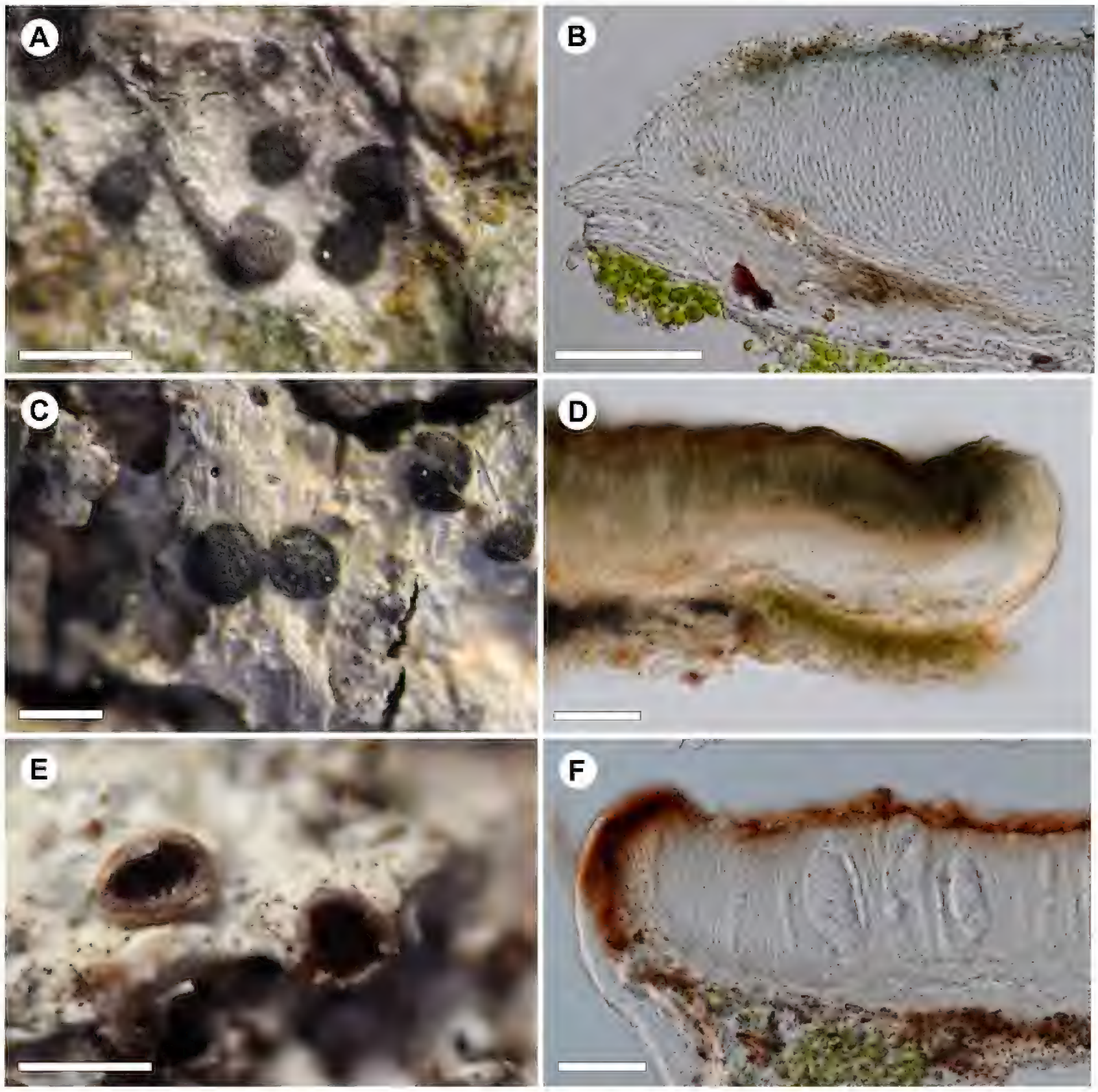


**Figure 2.** Morphology of *Clypeoria japonica*, *C. lambinonii* and *Gyalideopsis peruviana*. **A** & **B**, *C. japonica* (*K. Miyazawa 1036*, TNS); **C** & **D**, *C. lambinonii* (*K. Kalb s.n.* [Kalb, Lich. Neotrop. 64. as *Gyalideopsis lambinonii*], TNS); **E** & **F**, *Gyalideopsis peruviana* (*K. Kalb & A. Kalb s.n.* [Kalb, Lich. Neotrop. 462. *Gyalideopsis peruviana*], TNS). A, C & E, apothecia; C, D & F, a vertical section of the apothecium in each species. Scales = 0.5 mm in A, C & E, 50 µm in B, D & F.

No secondary substances were detected with HPTLC in any of the specimens examined. In most Gomphillaceae, including *Gyalideopsis*, secondary metabolites have been found to be absent (Lücking 2008, Lücking et al. 2006, Xavier-Leite et al. 2018).

**MOLECULAR PHYLOGENETIC ANALYSES.** – The tree topologies based on the concatenated alignment between NJ and ML showed no conflicts. Moreover, the topology of this reconstructed ML tree (Fig. 3) was similar to that of Xavier-Leite et al. (2022). However, whereas *Gyalideopsis* sp. (AY341373, AY341359) and *Bezerroplaca lucernifera* (Kalb & Vězda) Xavier-Leite, M. Cáceres & Lücking (as *Echinoplaca lucernifera* Kalb & Vězda: AY341370, AY341356) formed a sister group in fig. 5 of Xavier-Leite et al. (2022), these species do not form sister groups in our analyses (Fig. 3).

The sequences we generated from specimens of *Gyalideopsis japonica* clustered in a single clade with high support values (NJ/ML = 100/100) (Fig. 3). However, the genetic variation among different loci

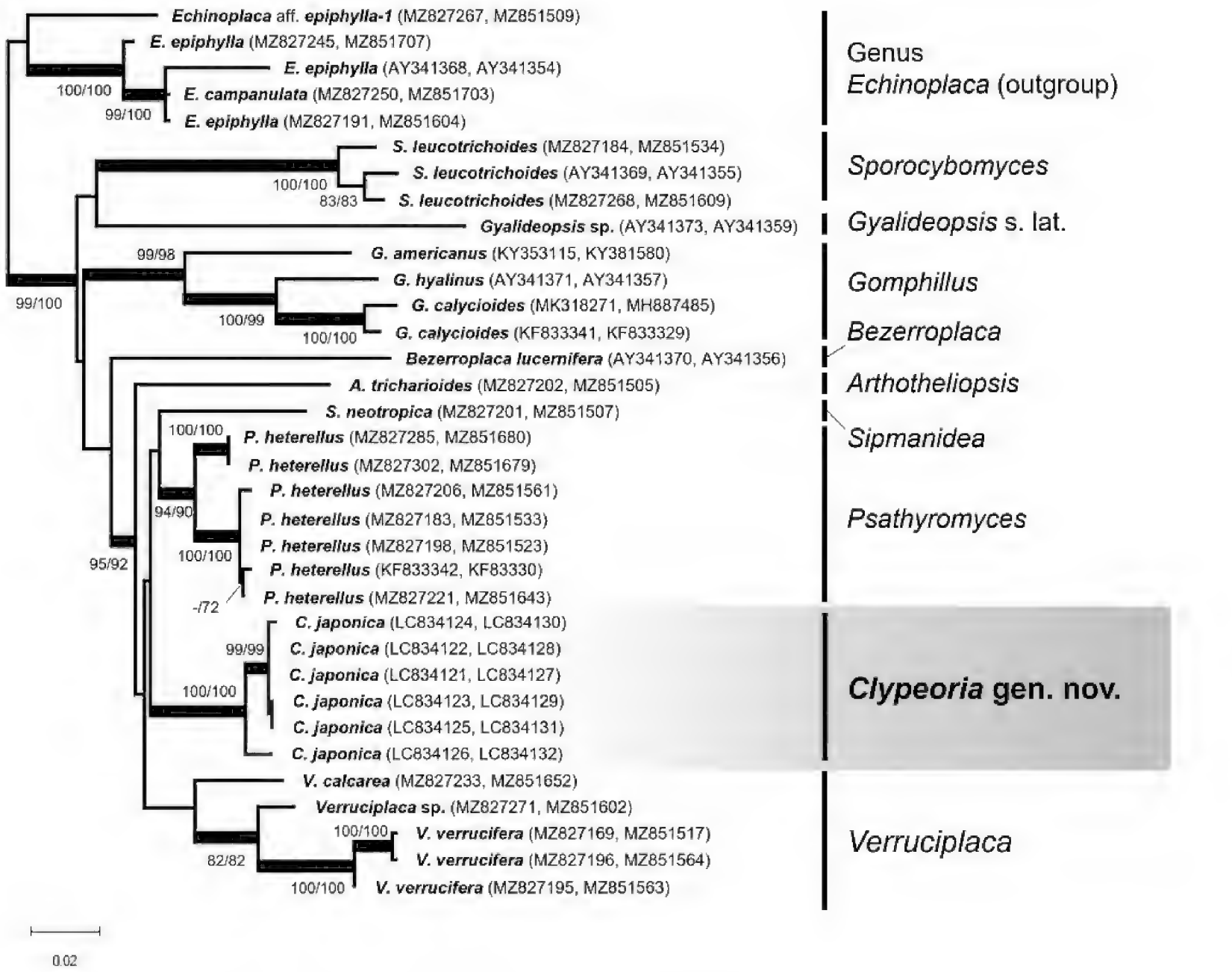


**Figure 3.** Maximum likelihood tree of selected taxa in *Gomphillaceae* showing the phylogenetic position of *Clypeoria japonica*. The genus *Echinoplaca* is used as an outgroup. ML (first) and NJ (second) support values (≥70) are presented for each node. Branches highly supported (≥90) by both analyses are indicated with bold black lines.

in the six sequenced specimens of *G. japonica* from Japan were as follows: nuITS (623 sites, 51 variables, 93.8–99.3% identity, n = 6), nuLSU (512 sites, 16 variables, 97.2–99.8% identity, n = 6), mtSSU (725 sites, 10 variables, 98.7–100% identity, n = 6), and *RPB2* (519 sites, 13 variables, 97.8–99.8% identity, n = 5). It should be noted that a minimum identity of 93.8% was observed among the specimens examined in the nuITS. Such low identity of nuITS is often recognized differences at the species level in lichens and non-lichen fungi (Kõljalg et al. 2013, Nilsson et al. 2008, Schoch et al. 2012). Because no morphological differences were observed among the specimens, and we consider this to reflect intraspecific variation.

The clade of *G. japonica* sequences was included in a strongly supported clade (NJ/ML = 95/92) containing the mostly foliicolous genera *Arthotheliopsis* Vain., *Psathyromyces* Bat. & Peres, *Sipmanidea* Xavier-Leite, M. Cáceres & Lücking, and *Verruciplaca* Xavier-Leite, M. Cáceres & Lücking (Fig. 3). These genera mostly produce adnate to spot-like apothecia (zeorine in *Sipmanidea*), but except in *Arthotheliopsis*, they are yellow-orange in color. They also differ strongly from both *G. japonica* and *G. lambinonii*, as well as from one another, in their hyphophore types (Xavier-Leite et al. 2022, 2023).

Unfortunately, DNA sequences of *G. peruviana* and other members of the *G. africana* group have not been obtained. However, the dispersed placement of members of *Gyalideopsis* s. lat in previously published phylogenies have already demonstrated the genus is polyphyletic (Xavier-Leite et al. 2022). Additionally, our analysis did not support a sister group relationship between *G. japonica*, and by extension *G. lambinonii*, and other members of *Gyalideopsis* s. lat. (Fig. 3). In light of these results, which are consistent with the findings of Lücking et al. (2005), there is clear evidence supporting the establishment of a new genus for *G. japonica* and *G. lambinonii*. Although it is clear that additional molecular phylogenetic

studies are required to clarify relationships among other members of *Gyalideopsis* s. lat., we propose the name *Clypeoria* for this group.

## TAXONOMIC SECTION

***Clypeoria*** K. Miyaz. & Y. Ohmura, **gen. nov.**
Mycobank #855679.

**DIAGNOSIS**. – *Clypeoria* is recognized by its clypeate hyphophores with a centrally reduced stipe on the underside (Figs. 1A–D), producing moniliform diaphyphae with drop-shaped terminal segments (Figs. 1E & F). It can be distinguished from the type species of *Gyalideopsis*, *G. peruviana*, by its adnate apothecia (Figs. 1A & B, 2A & C) and monosporous asci.

**TYPE SPECIES:** *Clypeoria japonica* (H. Harada & Vězda) K. Miyaz. & Y. Ohmura.

**GENUS DESCRIPTION**. – **Thallus** crustose, continuous, very thin, smooth, without sterile setae, greenish grey. **Apothecia** adnate, biatorine, rounded, 0.2–1.0 mm diam; disc brown to blackish brown; excipulum hyphal, colorless; hypothecium prosoplectenchymatous, colorless; epithecium indistinct. **Asci** monosporous, 40–80 × 15–30 µm. **Ascospores** ellipsoid, muriform, 35–60 ×15–30 µm, colorless. **Hyphophores** clypeate, almost adnate to the thallus, attached to the substrate by a central reduced stipe on the underside, 0.3–1.0 mm diam. with dissected margin, brown to black. **Diahyphae** composed of many fascicles, moniliform, with drop-shaped terminal segments. **Photobiont** trebouxioid (cf. Watanabeales). **Habitat** corticolous.

**CHEMISTRY**. – No secondary substances were detected with HPTLC.

**ETYMOLOGY**. – The genus name *Clypeoria* is derived from its clypeate (= round shield shaped) hyphophores, a term originated to the Latin *clypeus*. The suffix *-oria* was chosen to emphasize the distinctive clypeate hyphophores characteristic of this genus. In Latin, the suffix *-oria* is commonly used to form nouns that denote objects or places associated with specific features.

**NOTES**. – *Clypeoria* resembles *Arthotheliopsis* in the applanate to adnate apothecia but can be distinguished by the absence of sterile setae and the production of clypeate, rather than setiform, hyphophores (Lücking et al. 2007). *Sipmanidea*, previously classified as *Echinoplaca* (Xavier-Leite et al. 2023), shares production of monosporous muriform ascospores with *Clypeoria*, but differs in having erumpent to adnate apothecia that appear zeorine to emarginate with yellow-orange color and setiform, branched hyphophores. *Psathyromyces*, formerly included in *Aderkomyces* Bat., shares with *Clypeoria*, the adnate, biatorine apothecia and moniliform diahyphae, but differs in the orange color of the apothecia, the presence of long white setae, and long, setiform, white hyphophores with arrow-like, blackened apex, (Xavier-Leite et al. 2023). *Verruciplaca*, previously treated as a group within *Echinoplaca* s. lat. (Xavier-Leite et al. 2023), can be distinguished from *Clypeoria* by its whitish to bluish pruinose thallus, emarginate, orange apothecia (*Echinoplaca*-type), the thinly branched hyphophores usually formed on a translucent prothallus, and filiform diahyphae with spermatozoid terminal segments.

The hyphophores of *Gomphillus* are somewhat similar to those of *Clypeoria* in their clypeate shape with a central stipe on the underside (Lücking et al. 2005). However, *Gomphillus* has a long and distinct stipe, whereas in *Clypeoria* the stipe is much reduced (Lücking et al. 2005). In addition, *Clypeoria* has adnate biatorine apothecia, muriform ascospores, and moniliform diahyphae, while *Gomphillus* has vertically elongated apothecia, filiform ascospores, and filiform to acicular diahyphae (Lücking et al. 2005). Phylogenetic analyses in this study found support for the independence of these genera from one another. (Fig. 3).

According to the phenotype-based cladistic analysis by Lücking et al. (2005), *Clypeoria japonica* and *C. lambinonii* were treated as members within the *Gyalideopsis palmata* group. This group is characterized mainly by taxa that have flabelliform hyphophores and a corticolous habit (Lücking et al. 2005). However, the *G. palmata* group is apparently heterogeneous, containing species with morphologies ranging from sessile to shortly stalked apothecia, setiform to clypeate hyphophores, and filiform to moniliform diahyphae (Lücking et al. 2005). The molecular study by Xavier-Leite et al. (2022)

demonstrated that thalline, apothecial, and hyphophore characteristics are crucial in defining genus-level lineages within Gomphillaceae. Therefore, further taxonomic studies based on molecular data should address the *G. palmata* group in more detail. At present, the lack of molecular data for this group makes it difficult to conduct a comparative analysis with other taxa and *Clypeoria*.

One taxon '*Gyalideopsis* sp.' reported in Lücking et al. (2006) resembles *Clypeoria lambinonii* and *C. japonica* in having rounded hyphophores, but these differ in their pale color and the presence of a distinct stipe and likely this material does not belong to *Clypeoria*. Due to the lack of DNA sequences and the absence of apothecia and diahyphae, the taxonomic evaluation of '*Gyalideopsis* sp.' could not be conducted.

***Clypeoria japonica*** (H. Harada & Vězda) K. Miyaz. & Y. Ohmura, **comb. nov.**
Mycobank #855680.

≡ *Gyalideopsis japonica* H. Harada & Vězda, Nat. Hist. Res. 6: 5. 2000. **TYPE: JAPAN.** HONSHU. Chiba Pref.: Atago-zawa, Seiwa-kenmin-no-mori, Kimitsu-city, 120 m. elev., on trunk of *Swida controversa* by stream in forest, 10.xi.1997, *H. Harada 18543* (CBM-FL-10573[digital images!], holotype; PRA [n.v.], isotype).

**FIGURES 1A, 1C & 1E, 2A & 2B.**

**NOTES**. – *Clypeoria japonica* is characterized by having clypeate, adnate, dark brown to grayish black hyphophores (Figs. 1A & C) attached to the substrate by a central reduced stipe on the underside, with moniliform diahyphae (Fig. 1E), adnate blackish brown to grayish black apothecia with laterally spreading exciple (Figs. 1A, 2A & B), monosporous asci, and lack of representative lichen compounds. For detailed description and illustrations, see Harada and Vězda (2000).

**HABITAT AND DISTRIBUTION**. – This species is known only from the warm-temperate region of Japan, where it grows on barks of various coniferous and deciduous trees (see also Harada & Vězda 2000, Harada et al. 2017, Sakata & Harada 2012, Takahashi 2009, Yamamoto et al. 2024).

*Specimens examined*. – **JAPAN.** HONSHU. Chiba Pref.: near Seicho-ji Temple, Kiyosumi, Kamogawa-city (35°09′N, 140°08′E), 300 m. elev., 22.iii.2022., on bark of *Castanopsis sieboldii*, *K. Miyazawa 1036* (TNS; nuITS: LC834115). Hiroshima Pref., Higashihon-machi, Shobara-city (34°51′N, 133°01′E), 280 m. elev., 27.vi.2021., on bark of broad-leaf tree, *M. Chaki 79* (TNS; nuITS: LC834116; *RPB2*: LC834110); Nabara, Kabe-cho, Asakita-ku, Hiroshima-city (34°34′N, 132°30′E), 270 m. elev., 30.xii.2023., on bark of *Cerasus* sp., *M. Chaki 420* (TNS; nuITS: LC834119; *RPB2*: LC834113); campsite, Haji Dam, Yachiyo-cho, Akitakata-city (34°40′N, 132°35′E), about 250 m. elev., 11.vii.2021., on bark of broad-leaf tree, *M. Chaki 84* (TNS; nuITS: LC834117; *RPB2*: LC834111); Haji Dam, Yachiyo-cho, Akitakata-city (34°40′N, 132°36′E), about 260 m. elev., 19.vi.2022., on branch of *Cerasus* sp. *M. Chaki s.n. [= herb. Y. Ohmura 14150]* (TNS; nuITS: LC834120; *RPB2*: LC834114); Hatsukaichi-city, 30 m. elev., 29.viii.2021, on tree bark, *M. Chaki 137* (TNS), 10 m elev., 23.ix.2021., on bark broad-leaf tree, *M. Chaki 191* (TNS; nuITS: LC834118; *RPB2*: LC834112), about 20 m elev., 23.ix.2021., on bark, *M. Chaki 194* (TNS).

***Clypeoria lambinonii*** (Vězda) K. Miyaz. & Y. Ohmura**, comb. nov.**
Mycobank #855681.

≡ *Gyalideopsis lambinonii* Vězda, Folia Geobot. Phytotax. 14: 64. 1979. **TYPE**: **DEMOCRATIC REPUBLIC OF THE CONGO [ZAIRE].** Kivu. Prov: Kahuzi, 2640 m. elev., on bark of *Agarista salicifolia*, 28.xii.1972. *J. Lambinon* 71/1287 (PRA[n.v.], holotype; LG[n.v.], isotype).

**FIGURES 1B, 1D & 1F, 2C & 2D.**

**NOTES**. *Clypeoria lambinonii* resembles *C. japonica* in having clypeate adnate hyphophores (Figs. 1B & D) with moniliform diahyphae (Fig. 1F). However, it differs in having more blackish discs with compact exciple (Figs. 1B, 2C & D). See the detailed information on this species in the descriptions by

Vězda (1979) and the line drawings by Vězda (1979) and Kalb & Vězda (1988), as well as the images in Vězda (1979) and Lücking et al. (2007).

**HABITAT AND DISTRIBUTION**. – *Clypeoria lambinonii* was reported from tree bark at elevations between 100 and 3000 m in Asia (Philippines [Kalb & Vězda 1988), Taiwan [Aptroot & Sparrius 2003], Thailand [Aptroot et al. 2007], Vietnam [Aptroot & Sparrius 2006]), North and South America (Bolivia [Flakus et al. 2015], Brazil [Xavier Leite et al. 2018], Costa Rica [Lücking et al. 2006], U.S.A. (Florida) [Lücking et al. 2007], Venezuela [Komposch & Hafellner 2002]), and Africa (Democratic Republic of the Congo, Rwanda [Vězda 1979]).

*Specimen examined*. – **BRAZIL:** Mato Grosso. Serra dos Coroados: zwischen Cuiaba und Buriti, in einem dichten Cerrado, 500 m elev., 6.vii.1980., *K. Kalb s.n.* [= Kalb, Lich. Neotrop. 64., distributed as *Gyalideopsis lambinonii* Vězda] (TNS).

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# Contributions to the lichen flora of the province of Alberta, Canada, with the description of two new species and revised status for the subspecies of *Toninia tristis*

EINAR TIMDAL[1] AND SIRI RUI[2]

ABSTRACT. – We report 53 species collected on a field trip to Alberta in 2018. We produced 57 ITS and 2 mtSSU sequences from that material, and phylogenetic reconstructions are presented for a part of *Caloplaca* s. lat., the Elixiaceae, *Gypsoplaca*, *Thalloidima*, and the subspecies of *Toninia tristis*. Two species are new to science, the soil crust lichen *Caloplaca albosquamata* and the saxicolous *Elixia praeruptorum*, both from Jasper National Park. With the exception of an undescribed species from Alaska, all sequenced material of *Gypsoplaca* from North America is identified as *G. rosulata*; there is no evidence of *G. macrophylla* occurring in North America. *Thalloidima sedifolium* s. str. and *T. squamatum* (recently split from *T. sedifolium* s. lat.) are both shown to be present in continental North America. The 11 subspecies of *Toninia tristis* are raised to the species level and hence 10 new combinations are made. Additional species new to or confirmed from Alberta or Canada are *Aspicilia mashiginensis*, *Bryonora septentrionalis*, *Calvitimela melaleuca*, *Kiliasia sculpturata*, *Lecanora neodegelii*, *Psora vallesiaca*, *Rhizocarpon norvegicum*, *Thalloidima physaroides*, and *Toninia tristis* s. str.

KEYWORDS. – Floristics, lichenized Ascomycetes, molecular phylogenetics, soil crust lichens, thin-layer chromatography, new combinations, new species, taxonomy.

## INTRODUCTION

In July 2018, we visited Banff and Jasper National Parks in the province of Alberta, Canada, partly to collect material for our ongoing projects on lecideoid lichens (especially *Lecidea* s. str., *Miriquidica*, *Psora*, *Rhizocarpon*, and *Toninia* s. lat.). We took the opportunity to collect other species outside the parks assuming that the material would contribute to the knowledge of the lichen flora of Alberta and contribute to comparisons with European material. This included one day at Dry Island Buffalo Jump Provincial Park and one day at the Kootenay Plains Ecological Reserve where we worked with Toby Spribille, Gulnara Tagirdzhanova, and Göran Thor. We here report on the identified specimens in our material.

There are few published studies on the lichen flora of Banff and Jasper National Parks, the most comprehensive being John (1989) who listed 106 species from Jonas Rockslide, Jasper. Other papers, revealed by search in the *Recent Literature on Lichens* database, are mostly studies on vegetation with occasional mention of lichens.

## MATERIALS AND METHODS

HERBARIUM MATERIAL. – We collected 97 specimens in Alberta (Fig. 1), out of which 82 are reported on here. The remaining are still undetermined or will be included in more comprehensive

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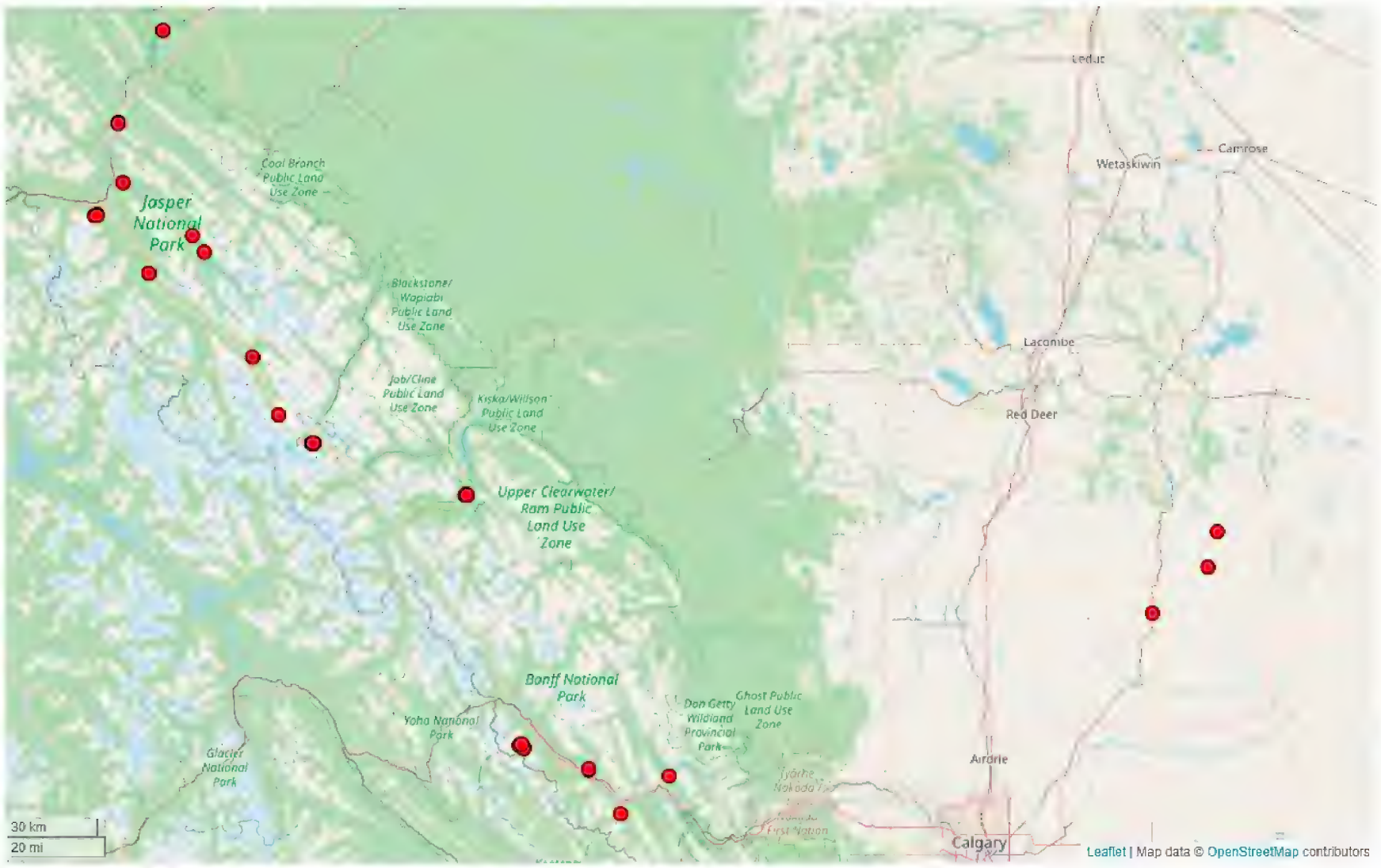


**Figure 1.** Map illustrating the locations of the collecting sites in Alberta, Canada visited during this study.

taxonomic works. Three days were spent in Banff National Park (30 collections) and five in Jasper National Park (42 collections). The geographical coordinates are in the WGS84 datum and are given with 10 m precision. Abbreviated habitat information is given in the citation of the specimens. The material is stored in O under the accession numbers L-223646 – L-223742. All 97 specimens are searchable on GBIF and CLH (2024). A permit for collecting in Banff and Jasper National Parks was granted by Parks Canada to us (permit JNP-2018-28918) and a permit for collecting in Dry Island Buffalo Jump Provincial Park and Kootenay Plains Ecological Reserve was granted by Alberta Environment and Parks to Toby Spribille (permit 2018 N/A_2).

MORPHOLOGY. – The collections were studied under dissecting and compound microscopes, in the latter in water and lactophenol cotton blue (LCB). The iodine reaction in the hymenium and asci was studied after pretreatment with 10% KOH in a modified Lugol's solution where water was replaced by 50% lactic acid. Chlor-Zinc-Iodine (Schultze reagent) was used to locate remnants of algae in the upper cortex. The length and breadth of the ascospores were measured at 1000 × magnification (oil immersion) using a Leitz Aristoplan compound microscope, and the measurements are given as $X \pm 1.5 \times SD$, where X is the arithmetic mean and SD is the sample standard deviation. Microscope images and lab macro images (Figs. 11, 12, 13, 14A, 14B, 15A, 15B, 17, 20, 21, 23, 24, 25A, 26) were made by a Nikon D800E camera. For the lab macro images, we used a Mikro-Nikkor 55 mm f/2.8 macro lens attached to a Nikon PB6 bellows and performed focus stacking on series of images by the free software Combine ZP (https://combinezp.software.informer.com). Field macro images (Figs 18, 19) were made by a Nikon D500 camera with Mikro-Nikkor 60 mm f/2.8D, without focus stacking.

THIN-LAYER CHROMATOGRAPHY. – 43 specimens were subjected to thin-layer chromatography (TLC), performed in accordance with the methods of Culberson (1972) and Culberson et al. (1981). We used solvent systems B' and C, and mainly aluminum plates but also glass plates when fatty acids were expected.

SEQUENCING. – In order to support the identifications, 31 specimens were sequenced for the ITS marker by the DNA barcoding project OLICH at the Natural History Museum, University of Oslo (NHMO) (https://nhm2.uio.no/lichens/barcode). Here we also publish 20 additional sequences of *Thalloidima* and

*Toninia tristis* (Th. Fr.) Th. Fr. previously produced by OLICH in order to increase the number of accessions in the phylogenetic reconstructions. The OLICH project is a part of the Norwegian Barcode of Life (NorBOL, Marthinsen et al. 2019). The DNA extraction, PCR amplification and sequencing were performed at the Canadian Centre for DNA Barcoding (CCDB; https://ccdb.ca) using the primers ITS1-F (Gardes & Bruns 1993) and ITS4 (White et al. 1990). In addition to the OLICH sequences, the lichen group at NHMO sequenced material of the two new species described here, *Caloplaca albosquamata* Timdal & Rui and *Elixia praeruptorum* Timdal & Rui, for the mtSSU marker using the primer pair mtSSU1/mtSSU3R (Zoller et al. 1999), 16 specimens of *Rhizocarpon*, *Thalloidima*, and *Toninia* for the ITS and partly the mtSSU markers, and the two specimens of *Calvitimela melaleuca* (Sommerf.) M.P. Andreev for the ITS, MCM7 and TEF1-α markers. Three of the *Rhizocarpon* sequences (ON324016, ON324017, ON332061) were published by Halıcı et al. (2022), the *Bryonora septentrionalis* Holt.-Hartw. sequence by Svensson et al. (2022), and all *Calvitimela* sequences by Fjelde et al. (2023). We hence publish 66 new ITS and 2 new mtSSU sequences in this paper.

BLASTN. – The new sequences were subjected to local BLASTn searches. Our BLASTn database consisted of all lichen sequences in GenBank (downloaded 2023-10-24), the general FASTA release of species hypotheses in the UNITE database ver. 18.07.2023 (Abarenkov et al. 2023), and our unpublished sequences produced by the OLICH project and the lichen group at NHMO.

PHYLOGENETIC RECONSTRUCTION. – Eight phylogenetic reconstructions were made. They included *Caloplaca* p.p. (ITS, mtSSU), *Elixia* (ITS, LSU, mtSSU), *Gypsoplaca* (ITS), *Thalloidima* (ITS), and the *Toninia tristis* complex (ITS). The reconstructions followed the same workflow: Selection of sequences, alignment, inspection and trimming of ends, reconstruction under the Bayesian inference (BI) and maximum likelihood (ML) criteria, and editing the BI trees; the details in this workflow are given below.

*Caloplaca.* – Initial BLASTn results of the ITS and mtSSU markers indicated that our specimen O L-233700 belonged in Teloschistaceae subfamily Caloplacoideae. For ITS, the genetic distance to the closest match was long, however, and none of the recently segregated genera of *Caloplaca* appeared to be suitable for a phylogenetic reconstruction with our specimen. We hence selected the 25 most similar GenBank accessions plus a closely matching species hypothesis (SH1097576.09FU) in the UNITE database for the ITS dataset. For mtSSU, a phylogenetic reconstruction with complete Teloschistaceae download from GenBank (not shown) indicated that its placement was close to the recently segregated genera *Pyrenodesmia* and *Lendemeriella*, hence the mtSSU sequences used by Frolov et al. (2021; complete) and Lee et al. (2023; *Lendemeriella* only) were selected for the dataset. Our *Caloplaca* datasets consisted of 27 ITS and 79 mtSSU sequences (see Appendix II: Table 1).

*Elixia.* – BLASTn results of the ITS marker indicated that our specimen O L-223687 belonged in the Elixiaceae and that it was conspecific with specimen *D. Stone 8170* (GenBank KF024743, identified as a *Miriquidica* sp.). That specimen was also represented by LSU sequence KF024745 in GenBank. The second genus of the Elixiaceae, *Meridianelia*, was represented by a single sequence in GenBank (mtSSU: FJ763185). Hence we downloaded all available ITS, LSU, and mtSSU sequences of the Elixiaceae in GenBank, plus a selection of sequences from the sister family Umbilicariaceae (see, Bendiksby & Timdal 2013) and the family Ophioparmaceae which was used as the outgroup. Our *Elixia* datasets consisted of 26 ITS, 20 LSU, and 20 mtSSU sequences (see Appendix II: Table 1).

*Gypsoplaca.* – The dataset consisted of our two sequences from Alberta plus all GenBank ITS sequences of the North American species *G. rosulata* H.X. Shi et al. (5) and of two of each of the four additional Asian species. *Protoparmelia isidiata* Diederich et al. was added as the outgroup following Shi et al. (2018). The dataset consists of 16 ITS sequences (see Appendix II: Table 1).

*Thalloidima.* – The dataset consisted of our six sequences from Alberta plus all ITS sequences available to us, i.e., those in Genbank (partly as *Toninia* spp.) and unpublished sequences produced by us. Three species of *Bibbya* were added as the outgroup following Westberg et al. (2023). The dataset consisted of 116 ITS sequences (see Appendix II: Table 1).

*Toninia tristis*. – The dataset consisted of our three sequences from Alberta plus all ITS sequences of *T. tristis* in GenBank (7), three unpublished OLICH sequences, and two public sequences in the BOLD database generated by the LIMW project (Lichens of the Intermontane West, curated by Steven D. Leavitt). Two GenBank sequences of *T. squalida* (Ach.) A. Massal. were added as the outgroup, hence the dataset consisted of 17 ITS sequences (see Appendix II: Table 1).

The eight datasets were iteratively aligned by SATé-II ver. 2.2.7 (Liu et al. 2012), using MAFFT ver. 6.717 (Katoh et al. 2005, Katoh & Toh 2008) as aligner, MUSCLE ver. 3.7 (Edgar 2004) as merger, FastTree ver. 2.1.4 (Price et al. 2010) as tree evaluator (i.e., under an approximate maximum likelihood criterion), and with the default settings in the GUI except that the number of iterations after last improvement in the maximum likelihood score was set to 10. The SATé alignments were inspected in BioEdit ver. 7.2.5 (Hall 1999) and trimmed at the ends, but in no cases further adjusted.

Phylogenies were reconstructed under Bayesian inference (BI) by MrBayes 3.2.7a (Huelsenbeck & Ronquist 2001, Ronquist & Huelsenbeck 2003) and under the maximum likelihood criterion (ML) by RAxML 8.2.12 (Stamatakis 2014). MrBayes was terminated after 0.6–1.8 million generations (ASDSF < 0.01), every 1000th generation was sampled, the burnin was set to 25%, and the phylogenetic trees were summarized as 50% majority rule consensus trees. RAxML was run using the raxmlGUI ver. 2.0.10 (Edler et al. 2021), using the bundled software ModelTest ver. 0.1.7 (Darriba et al. 2020) which estimated the best substitution models. We ran 1000 rapid bootstrap replicates. The BI consensus trees and the ML best trees were edited in TreeGraph 2 (Stöver & Müller 2010) and inspected for any topological incongruences. The BI trees were collapsed at posterior probability (PP) < 0.95 and the bootstrap values (BS) above 70% in the ML trees were manually transferred to the BI trees.

NEW RECORDS. – To assess whether species were new to Alberta or Canada, we consulted relevant literature, including McCune (2017), and the online databases *Consortium of Lichen Herbaria* (CLH 2024), *List of Elements in Alberta – lichens* (Environment and Parks 2022), *NatureServe Explorer* (NatureServe 2024), and the *Biodiversity Browser* at the Alberta Biodiversity Monitoring Institute (ABMI 2024).

The following symbols are used in the text below: * = New to Alberta; ** = New to or confirmed for Canada; *** = Confirmed for North America, **** = New to science.

## RESULTS

We identified 53 species in our material, among which two are new to science (*Caloplaca albosquamata* and *Elixia praeruptorum*), one is confirmed for North America (*Thalloidima sedifolium* (Scop.) Kistenich et al.), five are new to or confirmed for Canada (*Kiliasia sculpturata* (H. Magn.) Kistenich et al., *Lecanora neodegelii* B.D. Ryan & T.H. Nash, *Thalloidma physaroides* (Opiz) Opiz, *T. squamatum* (Hoffm.) M. Westb. & Timdal, *Toninia tristis*), and six are new to Alberta (*Aspicilia mashiginensis* (Zahlbr.) Oxner, *Bryonora septentrionalis*, *Calvitimela melaleuca*, *Gypsoplaca rosulata*, *Psora vallesiaca* (Schaer.) Timdal, *Rhizocarpon norvegicum* Räsänen). We produced 66 new ITS and 2 new mtSSU sequences for 37 species. The sequences used in the phylogenetic reconstructions are listed in Table 1, the remaining are referenced under the species accounts below. The results of the TLC examinations are given under the species accounts.

*Caloplaca*. – The local BLASTn search of the ITS sequence against BOLD and the NCBI nucleotide database gave no close match. The three most similar species were *Caloplaca monacensis* (Leder.) Lettau (87.5% similarity, 100% query coverage), *C. hanneshertelii* S.Y. Kondr. & Kärnefelt (87.0%, 100%), and *C. thracopontica* Vondrák & Soun (86.9%, 100%). The BLASTn search against the UNITE General FASTA release gave a much closer match: 97.3% similarity (100% query cover, 12 mismatches, 2 gaps) with species hypothesis SH1097576.09FU. The BLASTn search of the mtSSU sequence against the NCBI nucleotide database gave similarities in the range 96.8–98.1% for the top 20 matches, the most similar being *Olegblumia demissa* (Körb.) S.Y. Kondr. et al. followed in decreasing order by reference sequences of species belonging to the genera *Rufoplaca*, *Leproplaca*, *Caloplaca* s. lat., *Seirophora*, *Usnochroma*, *Variospora*, and *Pyrenodesmia*; all are members of Teloschistaceae subfamiliy Caloplacoideae (Arup et al. 2013).

The ITS alignment was 595 bp long. There were 230 variable sites and 157 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAI. MrBayes was terminated at

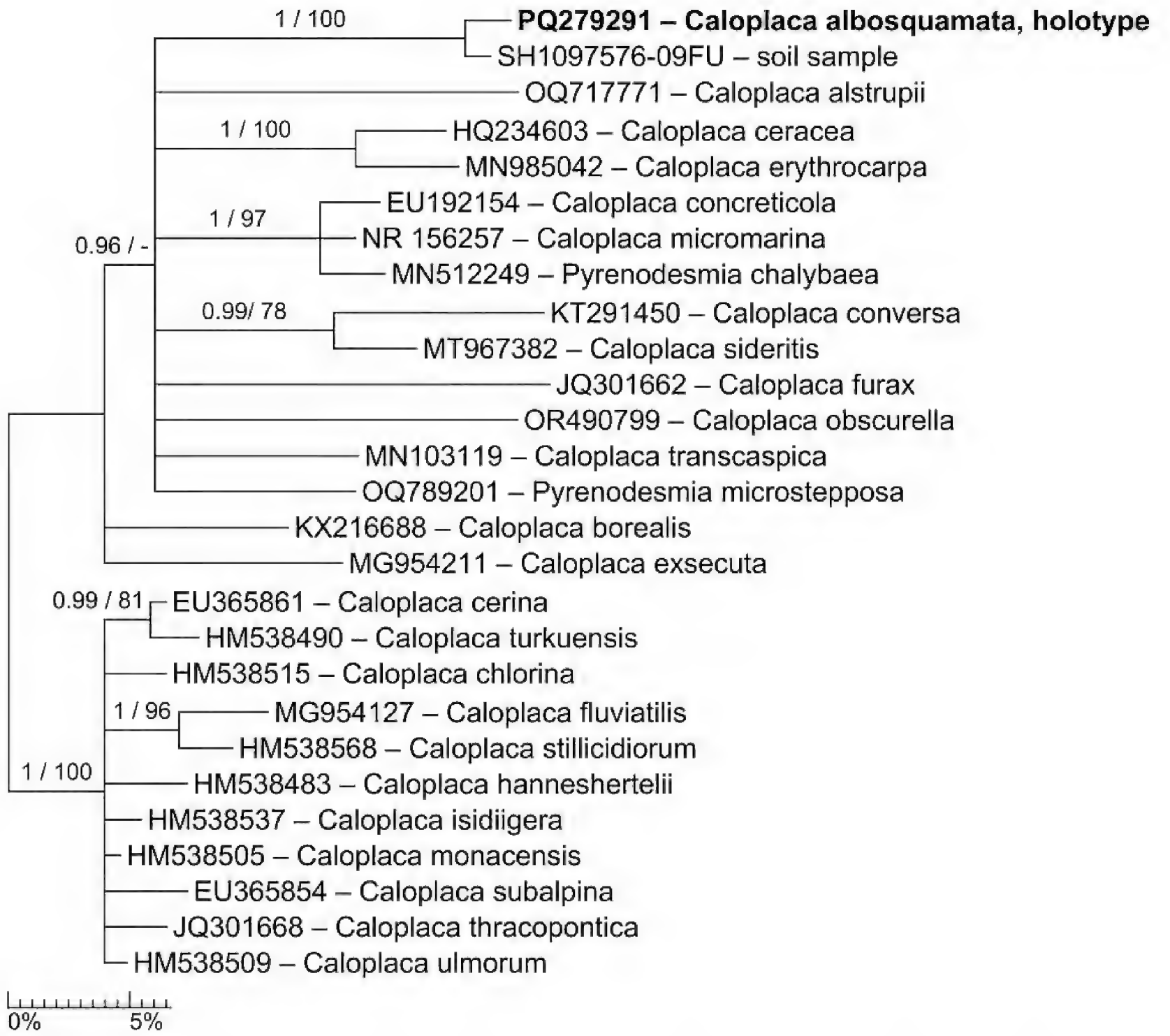


**Figure 2**. Unrooted Bayesian 50% majority rule consensus tree of selected *Caloplaca* ITS sequences, collapsed where PP < 0.95, of our sequence from Alberta, the 25 most similar sequences from a BLASTn search against the NCBI nucleotide database, and UNITE species hypothesis SH1097576. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequence from Alberta material is in bold text.

1.8 million generations, ASDSF = 0.009239. In the phylogenetic tree (Fig. 2), the sequence of the putative new species was recovered in a strongly supported (PP: 1, BS: 100%), long-branched clade with UNITE species hypothesis SH1097576-09FU. The clade was recovered in a polytomy with eight other long-branched clades or singletons.

The mtSSU alignment was 945 bp long. There were 249 variable sites and 152 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAIX. MrBayes was terminated at 1 million generations, ASDSF = 0.008954. In the phylogenetic tree (Fig. 3), the sequence of the putative new species was recovered as a long-branched singleton in a weakly supported (PP: 0.96, BS: 67%) clade. The clade consists of a polytomy with 14 genera (including *Caloplaca* s. str.) of the subfamily Caloplacoideae.

*Elixia*. – The local BLASTn search of our ITS sequence gave a 100% match (86% query cover) with the sequence KF024743 which was generated from a voucher collected in Oregon, U.S.A. (*D. Stone 8170*, OSC) identified as *Miriquidica* sp. The second most similar sequence was OQ717833, *E. flexella* (Ach.) Lumbsch, at 90.7% (472 bp alignment, 41 mismatchs, 3 gaps).

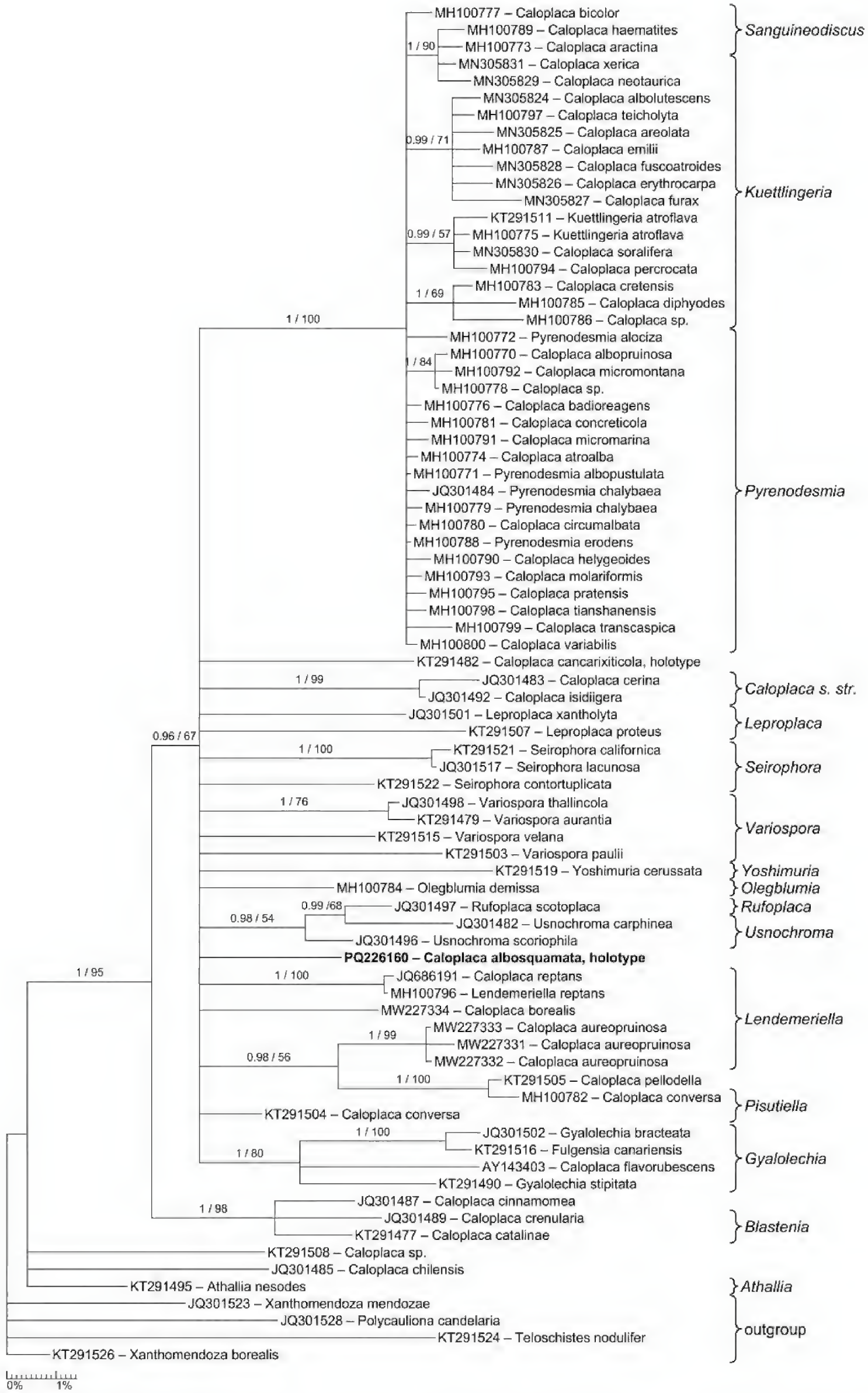


**Figure 3**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of a selection of mtSSU sequences of the Teloschistaceae subfam. Caloplacoideae. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequence from Alberta material is in bold text.

1 / 99
KF360371 – Elixia cretica – Australia
KF360372 – Elixia cretica – Mexico
0.99 / -
KF360373 – Elixia flexella – Austria
1 / 100
1 / 84
1 / 92
KF360374 – Elixia sp. – USA: AZ
KF360375 – Elixia sp. – USA: AZ
OQ717833 – Elixia flexella – Czechia
1/ 100
KF024743 – Elixia praeruptorum – USA: OR, paratype
PQ279269 – 19 Elixia praeruptorum – Canada: AB, holotype
Elixiaceae
KF360395 – Fulgidea oligospora – USA: AZ, holotype
1 / 100
KF360396 – Fulgidea oligospora – USA: AZ, paratype
KF360397 – Fulgidea oligospora – USA: AZ, paratype
1 / 90
KF360398 – Fulgidea oligospora – Russia, paratype
0.99 / 100
KF360402 – Fulgidea sierrae – USA: CA, paratype
KF360403 – Fulgidea sierrae – USA: CA, holotype
MH302517 – Umbilicaria hyperborea – USA: OR
0.99 / 73
MH302527 – Umbilicaria rigida – USA: AK
HM161490 – Umbilicaria vellea – Bolivia
1 / 85
KF360383 – Xylopsora caradocensis – Norway
MG309307 – Xylopsora canopeorum – USA: CA, holotype
KF360388 – Xylopsora friesii – Norway
Umbilicariaceae
MN483108 – Boreoplaca ultrafrigida – Russia
KY131776 – Ophioparma araucariae – China
1 / 99
KY131765 – Ophioparma handelii – China
KY266901 – Ophioparma lapponica – Norway
1 / 88
KY131767 – Ophioparma pruinosa – China
KF360415 – Ophioparma ventosa – Norway
Ophioparmaceae
0%
5%

**Figure 4**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available ITS sequences of the Elixiaceae and a selection from the Umbilicariaceae, with a selection from the Ophioparmaceae as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequence from Alberta material is in bold text.

1 / 100
KF360448 – Elixia cretica – Australia
KF360449 – Elixia cretica – Mexico
KF360450 – Elixia flexella – Austria
1 / 96
AY853368 – Elixia flexella – Turkey
0.97 / 88
AY300837 – Elixia flexella
KF360451 – Elixia sp. – USA: AZ
KF360452 – Elixia sp. – USA: AZ
KF024745 – Elixia praeruptorum – USA: OR, paratype
Elixiaceae
KF360465 – Fulgidea oligospora – USA: AZ, holotype
1 / 94
KF360466 – Fulgidea oligospora – USA: AZ, paratype
1 / 93
KF360467 – Fulgidea oligospora – USA: AZ, paratype
KF360468 – Fulgidea oligospora – Russia, paratype
0.96 / 82
KF360471 – Fulgidea sierrae – USA: CA, paratype
KF360459 – Xylopsora friesii – Norway
0.98 / 72
MH290351 – Umbilicaria hyperborea – USA: OR
HM161544 – Umbilicaria vellea – Bolivia
MH290347 – Umbilicaria rigida – USA: AK
Umbilicariaceae
MN460212 – Boreoplaca ultrafrigida – Russia
1 / 100
DQ973028 – Ophioparma lapponica
KF360474 – Ophioparma ventosa – Norway
Ophioparmaceae
0%
2%

**Figure 5**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available LSU sequences of the Elixiaceae and a selection from the Umbilicariaceae, with a selection from the Ophioparmaceae as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree.

0.99 / 85
GQ892058 – Elixia cretica – Greece, holotype
KF360419 – Elixia cretica – Mexico
AY300887 – Elixia flexella
1 / 100
AY853320 – Elixia flexella – Turkey
KF360420 – Elixia flexella – Austria
1 / 94
OQ646214 – Elixia flexella – Czechia
FJ763185 – Meridianelia maccarthyana – Tasmania, isotype
PQ226159 – Elixia praeruptorum – Canada: AB, holotype
Elixiaceae
KF360434 – Fulgidea oligospora – USA: AZ, paratype
1 / 100
KF360435 – Fulgidea oligospora – USA: AZ, paratype
KF360437 – Fulgidea sierrae – USA: CA, paratype
AY853349 – Umbilicaria hyperborea – Norway
1 / 100
DQ986873 – Umbilicaria rigida
HM161585 – Umbilicaria vellea – Bolivia
1
1 / 100
MG309311 – Xylopsora canopeorum – USA: CA, holotype
1 / 100
KF360428 – Xylopsora friesii – Norway
KF360425 – Xylopsora caradocensis – Sweden
Umbilicariaceae
1 / 100
MN508266 – Boreoplaca ultrafrigida – Russia
1 / 100
KF360443 – Ophioparma lapponica – Norway
KF360444 – Ophioparma ventosa – Norway
Ophioparmaceae
0%
5%

**Figure 6**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available mtSSU sequences of the Elixiaceae and a selection from the Umbilicariaceae, with a selection from the Ophioparmaceae as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequence from Alberta material is in bold text.

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The ITS alignment was 494 bp long. There were 188 variable sites and 135 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAX. MrBayes was terminated at 1 million generations, ASDSF = 0.007980. Our sequence and that of *Stone 8170* were recovered in the phylogenetic tree (Fig. 4) in a trichotomy with the two other known species of *Elixia*, *E. cretica* T. Sprib. & Lumbsch and *E. flexella*. The *Elixia* clade was highly supported (PP: 1, BS: 100%).

The LSU alignment was 876 bp long. There were 139 variable sites and 76 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAIX. MrBayes was terminated at 1 million generations, ASDSF = 0.009566. In the phylogenetic tree (Fig. 5), the sequence of the putative new species (*Stone 8170*) was recovered as basal in the *Elixia* clade. The two other *Elixia* species formed a highly supported (PP: 1, BS: 96%) clade, and the whole *Elixia* clade was well supported (PP: 0.97, BS: 88%).

The mtSSU alignment was 786 bp long. There were 176 variable sites and 124 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAX. MrBayes was terminated at 0.6 million generations, ASDSF = 0.009458. In the phylogenetic tree (Fig. 6), the putative new species was recovered as basal in the Elixiaceae clade. The remaining accessions of the family, including that of *Meridianelia maccarthyana* Kantvilas & Lumbsch, formed a highly supported clade (PP: 1, BS: 100%).

*Gypsoplaca*. – The ITS alignment was 563 bp long. There were 138 variable sites and 37 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAX. MrBayes was terminated at 1 million generations, ASDSF = 0.009152. In the phylogenetic tree (Fig. 7), the two sequences from Alberta were recovered in a weakly supported clade (PP: 0.95, BS: 83%) together with the other accessions of *G. rosulata*.

*Thalloidima*. – The ITS alignment was 650 bp long. There were 317 variable sites and 269 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAIX. MrBayes was terminated at 1.2 million generations, ASDSF = 0.008329. In the phylogenetic tree (Fig. 8), the sequences generated from material of the five species collected by us in Alberta, *T. alutaceum* Anzi, *T. candidum* (Weber) A. Massal., *T. physaroides*, *T. sedifolium*, and *T. squamatum*, were all recovered in their corresponding species-level clades. All five clades were highly supported (PP: 1.00, BS: 99–100%) and, with the exception of the *T. sedifolium* clade, were long-branched and showed only short or moderate

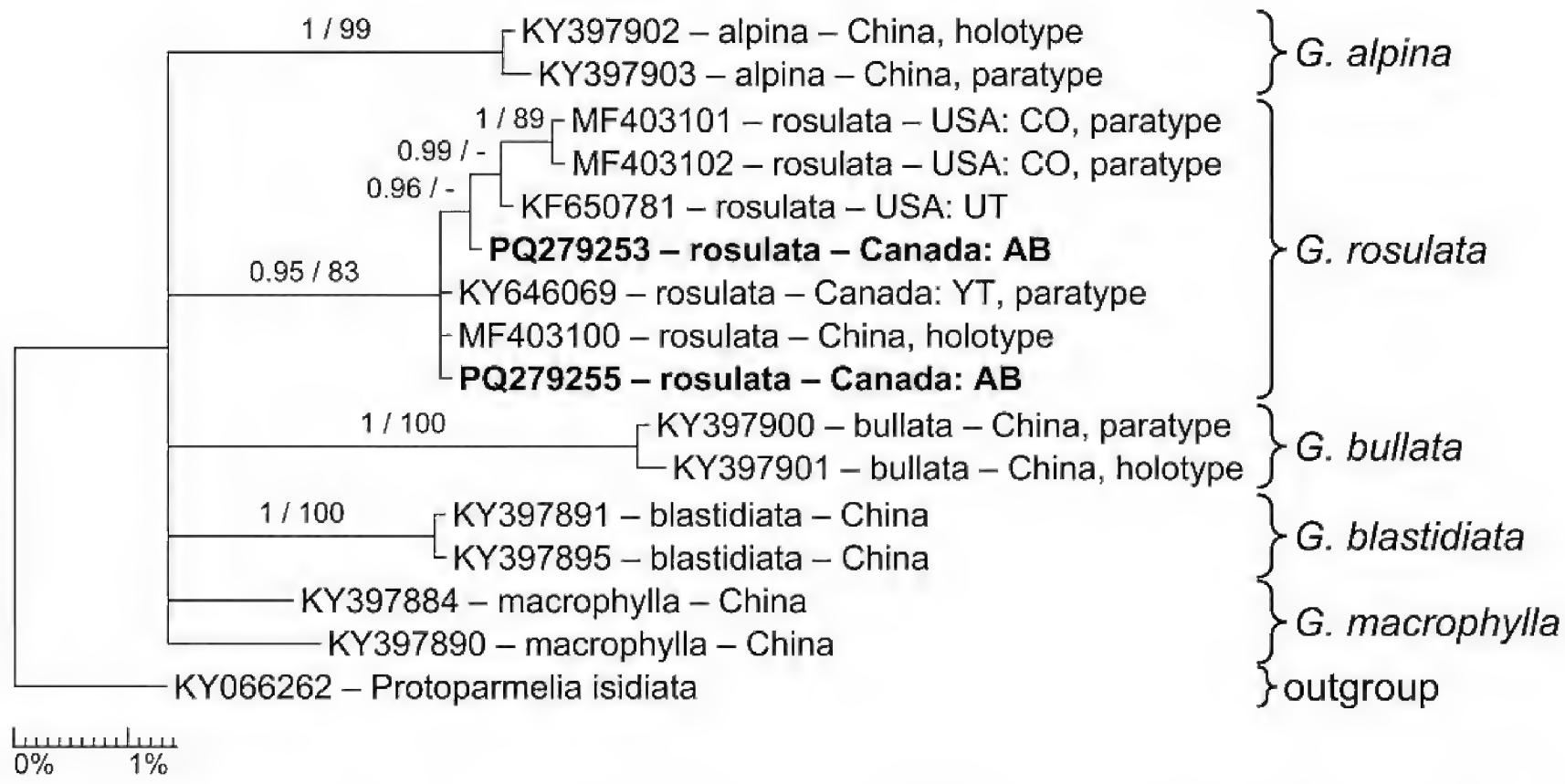

1 / 99
KY397902 – alpina – China, holotype
KY397903 – alpina – China, paratype
G. alpina
1 / 89
MF403101 – rosulata – USA: CO, paratype
0.99 / -
MF403102 – rosulata – USA: CO, paratype
0.96 / -
KF650781 – rosulata – USA: UT
PQ279253 – rosulata – Canada: AB
0.95 / 83
KY646069 – rosulata – Canada: YT, paratype
MF403100 – rosulata – China, holotype
PQ279255 – rosulata – Canada: AB
G. rosulata
1 / 100
KY397900 – bullata – China, paratype
KY397901 – bullata – China, holotype
G. bullata
1 / 100
KY397891 – blastidiata – China
KY397895 – blastidiata – China
G. blastidiata
KY397884 – macrophylla – China
KY397890 – macrophylla – China
G. macrophylla
KY066262 – Protoparmelia isidiata
outgroup
0%
1%

**Figure 7**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available ITS sequences of *Gypsoplaca rosulata* and a selection from other species of the genus, with *Protoparmelia isidiata* as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequences from Alberta material are in bold text.

internal distances. This was generally true for all species in the *Thalloidima* phylogeny, the exceptions being *T. albilabrum* (Dufour) Flagey, *T. sedifolium*, and *T. toepfferi* Stein.

*Toninia tristis*. – The ITS alignment was 580 bp long. There were 186 variable sites and 131 parsimony informative sites. ModelTest estimated the best substitution model to be GTRGAMMAX. MrBayes was terminated at 1 million generations, ASDSF = 0.008513. The phylogenetic tree (Fig. 9), included representative sequences from four of the 11 currently recognized subspecies of *T. tristis* (i.e., *T. tristis* ssp. *asiae-centralis* (H. Magn.) Timdal, *T. tristis* ssp. *pseudotabacina* Timdal, *T. tristis* ssp. *scholanderi* (Lynge) Timdal, and *T. tristis* ssp. *tristis* were sampled). The four subspecies were recovered in highly supported (PP: 1, BS: 100%), long-branched clades. Our three sequenced specimens from Alberta were recovered in their respective clades that corresponded to the subspecies as identified by morphology and chemistry (i.e., *T. tristis* ssp. *asia-centralis* [2] and *T. tristis* ssp. *tristis* [1]).

## DISCUSSION

*Caloplaca*. – The similarity in the ITS sequences between the putative new species and UNITE species hypothesis SH1097576-09FU (97.3%) is close to what could be expected of intraspecific variation (e.g., Marthinsen et al. 2019). We have no information on the morphology of that species hypothesis, however, and cannot state that they are conspecific. SH1097576-09FU originates from a soil sample (S611) from the Indian Himalayas, Jammu and Kashmir Region, Nubra valley, Sumur, 34.66133°N, 77.75245°E, 5270 m. alt., made by an unknown collector on 04 September 2015 (UNITE 2024).

The BLASTn searches and phylogenetic reconstructions (Figs. 2, 3) neither placed the putative new species with support in any of the currently accepted genera of Teloschistaceae subgenus Caloplacoideae, nor did they reveal any closely related sequenced species. The squamulose growth form of our specimen made us consider the possibility the species may have been described as a catapyrenoid or psoroid lichen. There are no species of the former group with the same dispersal strategy (soredia), however (Breuss 2010). In the latter group, *Trapeliopsis steppica* McCune & Camacho is the morphologically most similar species (see species treatment below). Although we are not experts on *Caloplaca* taxonomy, we have never encountered a morphologically similar species and believe our specimen belongs in a species new to science that we here describe as *Caloplaca albosquamata*. Lack of s-

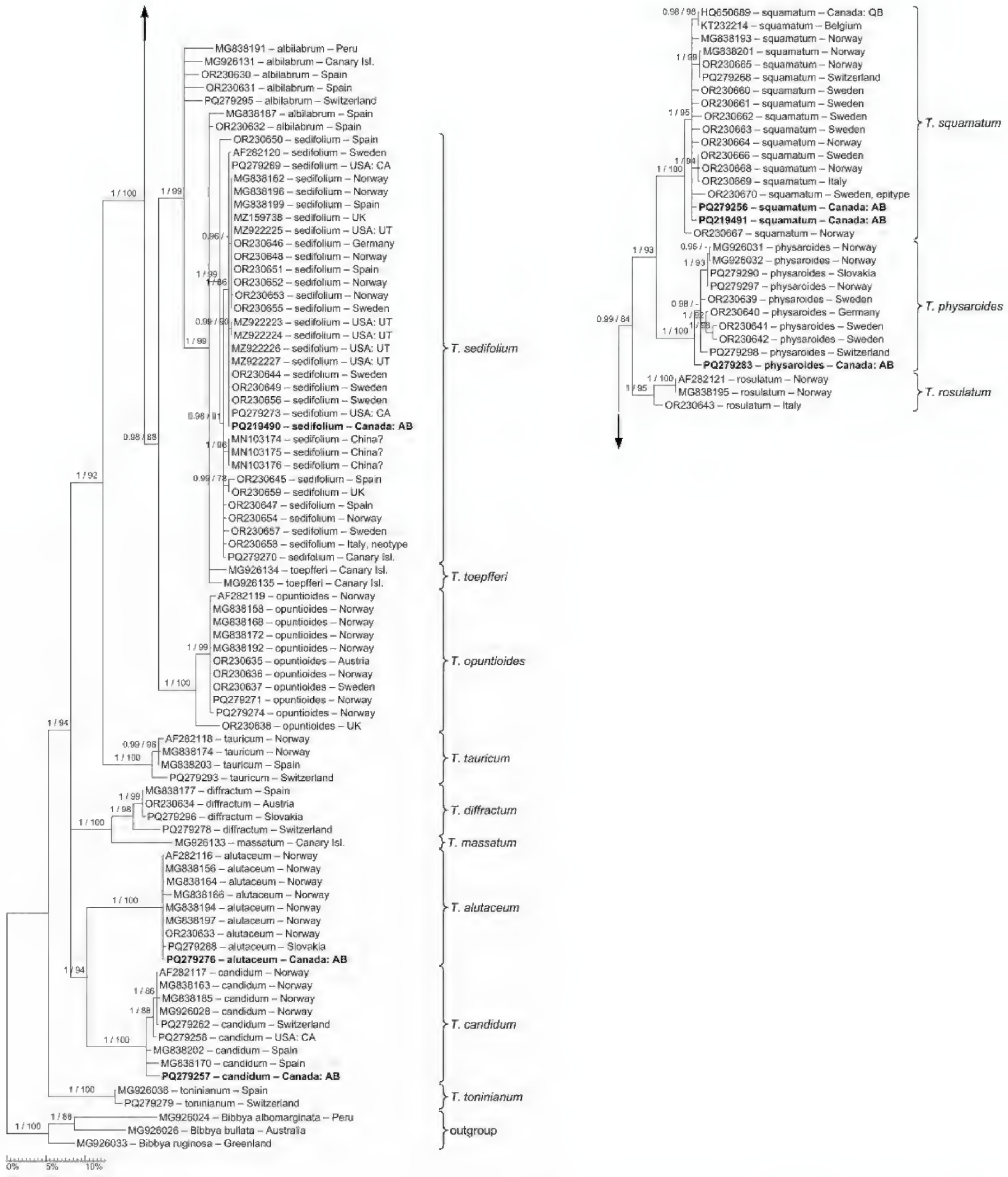

MG838191 – albilabrum – Peru
MG926131 – albilabrum – Canary Isl.
OR230630 – albilabrum – Spain
OR230631 – albilabrum – Spain
PQ279295 – albilabrum – Switzerland
MG838187 – albilabrum – Spain
OR230632 – albilabrum – Spain
OR230650 – sedifolium – Spain
AF282120 – sedifolium – Sweden
PQ279289 – sedifolium – USA: CA
MG838162 – sedifolium – Norway
MG838196 – sedifolium – Norway
MG838199 – sedifolium – Spain
MZ159738 – sedifolium – UK
MZ922225 – sedifolium – USA: UT
OR230646 – sedifolium – Germany
OR230648 – sedifolium – Norway
OR230651 – sedifolium – Spain
OR230652 – sedifolium – Norway
OR230653 – sedifolium – Norway
OR230655 – sedifolium – Sweden
MZ922223 – sedifolium – USA: UT
MZ922224 – sedifolium – USA: UT
MZ922226 – sedifolium – USA: UT
MZ922227 – sedifolium – USA: UT
OR230644 – sedifolium – Sweden
OR230649 – sedifolium – Sweden
OR230656 – sedifolium – Sweden
PQ279273 – sedifolium – USA: CA
PQ219490 – sedifolium – Canada: AB
MN103174 – sedifolium – China?
MN103175 – sedifolium – China?
MN103176 – sedifolium – China?
OR230645 – sedifolium – Spain
OR230659 – sedifolium – UK
OR230647 – sedifolium – Spain
OR230654 – sedifolium – Norway
OR230657 – sedifolium – Sweden
OR230658 – sedifolium – Italy, neotype
PQ279270 – sedifolium – Canary Isl.
T. sedifolium
MG926134 – toepfferi – Canary Isl.
MG926135 – toepfferi – Canary Isl.
T. toepfferi
AF282119 – opuntioides – Norway
MG838158 – opuntioides – Norway
MG838168 – opuntioides – Norway
MG838172 – opuntioides – Norway
MG838192 – opuntioides – Norway
OR230635 – opuntioides – Austria
OR230636 – opuntioides – Norway
OR230637 – opuntioides – Sweden
PQ279271 – opuntioides – Norway
PQ279274 – opuntioides – Norway
OR230638 – opuntioides – UK
T. opuntioides
AF282118 – tauricum – Norway
MG838174 – tauricum – Norway
MG838203 – tauricum – Spain
PQ279293 – tauricum – Switzerland
T. tauricum
MG838177 – diffractum – Spain
OR230634 – diffractum – Austria
PQ279296 – diffractum – Slovakia
PQ279278 – diffractum – Switzerland
T. diffractum
MG926133 – massatum – Canary Isl.
T. massatum
AF282116 – alutaceum – Norway
MG838156 – alutaceum – Norway
MG838164 – alutaceum – Norway
MG838166 – alutaceum – Norway
MG838194 – alutaceum – Norway
MG838197 – alutaceum – Norway
OR230633 – alutaceum – Norway
PQ279268 – alutaceum – Slovakia
PQ279276 – alutaceum – Canada: AB
T. alutaceum
AF282117 – candidum – Norway
MG838163 – candidum – Norway
MG838185 – candidum – Norway
MG926028 – candidum – Norway
PQ279262 – candidum – Switzerland
PQ279258 – candidum – USA: CA
MG838202 – candidum – Spain
MG838170 – candidum – Spain
PQ279257 – candidum – Canada: AB
T. candidum
MG926036 – toninianum – Spain
PQ279279 – toninianum – Switzerland
T. toninianum
MG926024 – Bibbya albomarginata – Peru
MG926026 – Bibbya bullata – Australia
MG926033 – Bibbya ruginosa – Greenland
outgroup
0%
5%
10%
HQ650689 – squamatum – Canada: QB
KT232214 – squamatum – Belgium
MG838193 – squamatum – Norway
MG838201 – squamatum – Norway
OR230665 – squamatum – Norway
PQ279268 – squamatum – Switzerland
OR230660 – squamatum – Sweden
OR230661 – squamatum – Sweden
OR230662 – squamatum – Sweden
OR230663 – squamatum – Sweden
OR230664 – squamatum – Norway
OR230666 – squamatum – Sweden
OR230668 – squamatum – Norway
OR230669 – squamatum – Italy
OR230670 – squamatum – Sweden, epitype
PQ279256 – squamatum – Canada: AB
PQ219491 – squamatum – Canada: AB
OR230667 – squamatum – Norway
T. squamatum
MG926031 – physaroides – Norway
MG926032 – physaroides – Norway
PQ279290 – physaroides – Slovakia
PQ279297 – physaroides – Norway
OR230639 – physaroides – Sweden
OR230640 – physaroides – Germany
OR230641 – physaroides – Sweden
OR230642 – physaroides – Sweden
PQ279298 – physaroides – Switzerland
PQ279283 – physaroides – Canada: AB
T. physaroides
AF282121 – rosulatum – Norway
MG838195 – rosulatum – Norway
OR230643 – rosulatum – Italy
T. rosulatum

**Figure 8**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available ITS sequences of *Thalloidima*, with *Bibbya* as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequences from Alberta material are in bold text. The thickened arrows indicate connection points between the two sections of the tree.

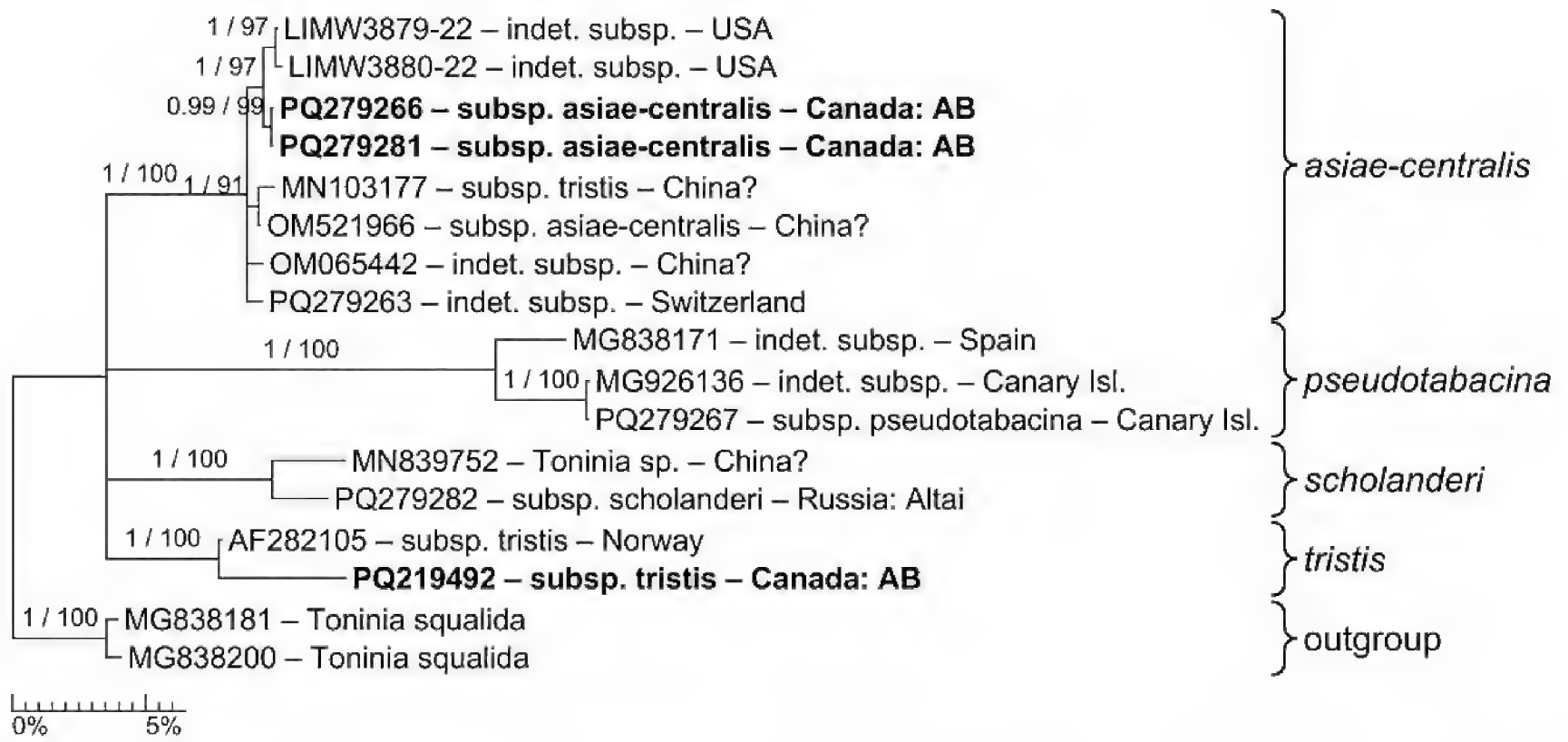

1 / 97
LIMW3879-22 – indet. subsp. – USA
1 / 97
LIMW3880-22 – indet. subsp. – USA
0.99 / 99
PQ279266 – subsp. asiae-centralis – Canada: AB
PQ279281 – subsp. asiae-centralis – Canada: AB
1 / 100
1 / 91
MN103177 – subsp. tristis – China?
OM521966 – subsp. asiae-centralis – China?
OM065442 – indet. subsp. – China?
PQ279263 – indet. subsp. – Switzerland
asiae-centralis
1 / 100
MG838171 – indet. subsp. – Spain
1 / 100
MG926136 – indet. subsp. – Canary Isl.
PQ279267 – subsp. pseudotabacina – Canary Isl.
pseudotabacina
1 / 100
MN839752 – Toninia sp. – China?
PQ279282 – subsp. scholanderi – Russia: Altai
scholanderi
1 / 100
AF282105 – subsp. tristis – Norway
PQ219492 – subsp. tristis – Canada: AB
tristis
1 / 100
MG838181 – Toninia squalida
MG838200 – Toninia squalida
outgroup
0%
5%

**Figure 9**. Bayesian 50% majority rule consensus tree, collapsed where PP < 0.95, of all available ITS sequences of *Toninia tristis* s. lat. with *T. squalida* as outgroup. Support values for the branches are given as PP/BS (for PP≥0.95/BS≥70%); the latter values are transferred from a congruent maximum likelihood tree. The newly generated sequences from Alberta material are in bold text.

-upport for placement in any of the newer generic divisions of *Caloplaca* might justify placing it in a new genus. We find that premature, however, having only ITS and mtSSU sequences, and assign it to *Caloplaca* as a temporary placeholder.

*Elixia*. – The 100% similarity between ITS sequences of our specimen and *Stone 8170*, and the morphological and chemical similarity between the specimens (see the entry in the Taxonomy section, below) suggest that they are conspecific.

Our three phylogenetic reconstructions recovered our specimen O L-223687 in the Elixiaceae with high support (PP: 0.97–1, BS: 88–100%). The family consists of two genera, *Elixia* and *Meridianelia*, with a total of three species (Lücking et al. 2017). None of them resemble our specimen morphologically (see below), hence we refer to our specimen as a putative new species. In the ITS and LSU phylogenies, in which *Elixia* was the only representative of the family, the putative new species was either recovered in a trichotomy with the two other known *Elixia* species (ITS, Fig. 4) or basal in the family (LSU, Fig. 5). In the mtSSU phylogeny (Fig. 6), which also included *Meridianelia*, it was recovered as the sister to the highly supported (PP: 1, BS: 100%) *Elixia–Meridianelia* clade. This indicates that the putative new species should either be placed in a new genus within the Elixiaceae, or *Meridianelia* should be synonymized with *Elixia*. Due to morphological considerations, especially of the ascus type (Fig. 15I, J), and the few sequences available, we refrain from either and place the putative new species in *Elixia*. Although we were not able to observe the apical deeper amyloid zone in the tholus in the ascus of our material, as illustrated from *Elixia* by Kantvilas & Lumbsch (2009: Fig. 3D) and Spribille & Lumbsch (2010: Fig. 2D), we consider the ovate to shortly clavate ascus with a thin, evenly amyloid tholus to be sufficiently similar to conform with the *Elixia* type. This ascus type is clearly different from that found in *Meridianelia*, which has a cylindrical ascus with a well-developed tholus containing an apical amyloid plug (Kantvilas & Lumbsch 2009).

The two previously known species of *Elixia*, *E. cretica* and *E. flexella*, grow on bark and wood, often decaying or sometimes burnt, the latter also rarely grows on rock (Spribille & Lumbsch 2010, Bendiksby & Timdal 2013, Westberg et al. 2021). Both species have lirelloid or star-shaped apothecia and lack lichen substances; the former develops an areolate thallus, the latter is crypothalline (Spribille & Lumbsch 2010). The new species forms round or at most somewhat elongated or irregular apothecia and contains norstictic acid both in the thallus and apothecia. The thallus is areolate with a well-developed hypothallus. These characters are not considered to be important at the genus level, but rather indicate that our material represents a species new to science and we describe it as *E. praeruptorum* below.

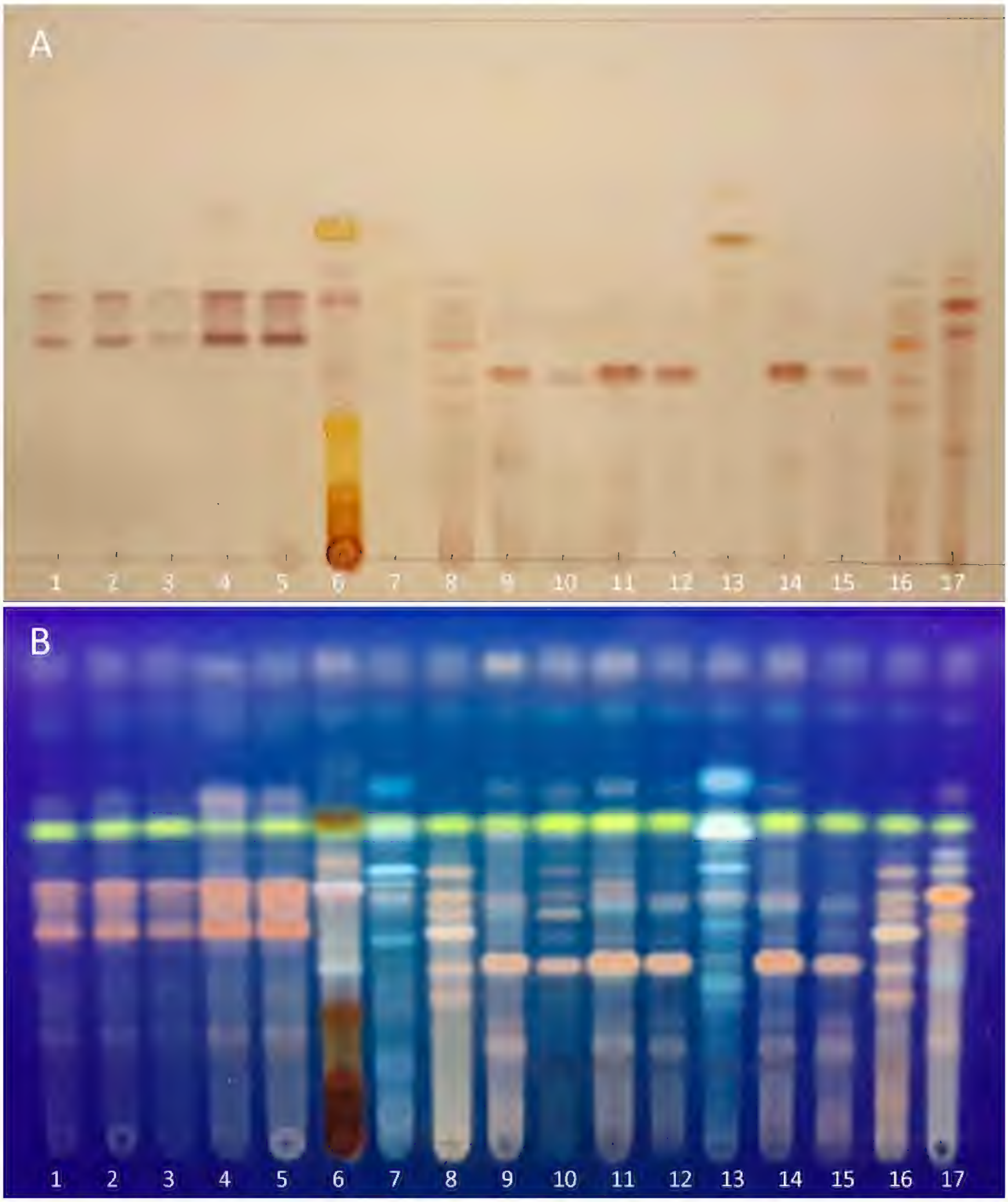



**Figure 10**. TLC chromatogram of *Gypsoplaca rosulata* (lanes 1–5) and the *Toninia tristis* complex (lanes 7–17), in solvent system C. **A**, in visible light; **B**, in UV 366 nm; both after treatment with sulphuric acid and heat. Lane 1: O L-205480, Colorado; lane 2: O L-184673, Yukon; lane 3: O L-205493, Colorado; lane 4: O L-223677, Alberta; lane 5: O L-223740, Alberta; lane 6: references (atranorin, norstictic acid); lane 7: O L-59930, subsp. *tristis*, Arizona; lane 8: O L-127198, subsp. *scholanderi*, Greenland; lane 9: O L-139110, subsp. *asiae-centralis*, Greenland; lane 10: O L-121992, subsp. *asiae-centralis*, Colorado; lane 11: O L-223679, subsp. *asiae-centralis*, Alberta; lane 12: O L-223681, subsp. *asiae-centralis*, Alberta; lane 13: O L-223703, subsp. *tristis*, Alberta; lane 14: O L-223708, subsp. *asiae-centralis*, Alberta; lane 15: O L-204895, subsp. *asiae-centralis*, Switzerland; lane 16: O L-208741, subsp. *scholanderi*, Russia; lane 17: O L-228577, subsp. *pseudotabacina*, Canary Islands. Compounds occurring in all lanes, e.g. the bright green in UV 366 nm, are contaminations from the acetone.

*Gypsoplaca.* – The genus *Gypsoplaca* Timdal, originally described for the single species *G. macrophylla* (Zahlbr.) Timdal (Timdal 1990), was expanded to include five species by Shi et al. (2018). All sequenced North American specimens, except one from Alaska, were identified as the new species *G. rosulata* by Shi et al. (2018). The one from Alaska (*Spribille 38752*; represented by an LSU sequence only) was recovered as basal in *Gypsoplaca* and left undetermined to species. All other sequenced material of *Gypsoplaca* examined by Shi et al. (2018), including that of the type species *G. macrophylla*, originated from Asia.

Timdal (1990) examined 12 specimens of *Gypsoplaca* from Asia (China) and multiple locations in North America (Alaska and Colorado, U.S.A., Northwest Territories and Yukon, Canada, and Greenland). The material was chemically heterogeneous; three chemotypes occurred in China, two in Canada and U.S.A., and one in Greenland – this probably reflecting the phylogenetic heterogeneity revealed by Shi et al. (2018). The most common North American chemotype reported by Timdal (1990) occurred in seven of the eight examined specimens from Canada and U.S.A. It was characterized by two major unknown terpenoids (Fig. 10) and was represented in the phylogeny of Shi et al. (2018) by ITS sequence MF403102 (generated from *W.A. Weber, Lich. Exs. COLO 700*, O L-205493). We here report the same chemotype in MF403101 (O L-205480) and KY646069 (O L-184673), both of which were included in the phylogeny published by Shi et al. (2018) and identified as *G. rosulata*. We hence assume that this chemotype is diagnostic for that species, and, if so, all but one of the specimens identified as *G. macrophylla* from Canada and U.S.A. by Timdal (1990) are *G. rosulata*. It is likely that the last North American specimen examined by Timdal (1990, collected in Alaska, *Thomson & Shushan 9141*, WIS), is conspecific with the undetermined Alaskan specimen included in the phylogeny of Shi et al. (2018). There have been several subsequent reports of *G. macrophylla* from North America, including from Alberta (Environment and Parks 2022, CLH 2024), but in the absence of confirmation by molecular or chemical analyses they all presumably belong in *G. rosulata* or the unnamed species from Alaska. Based on our results *G. macrophylla* should be removed from the North American checklist. The specimens named *G. macrophylla* from Greenland (Timdal 1990) and Europe (Poelt & Gärtner 1992) have not been sequenced and their identities should be considered both unresolved and likely not to be *G. macrophylla*.

*Thalloidima.* – Our phylogenetic tree (Fig. 8) is based on the largest set of ITS sequences published to date and confirms our identifications of *T. alutaceum*, *T. candidum*, *T. physaroides*, *T. sedifolium*, and *T. squamatum* in Alberta.

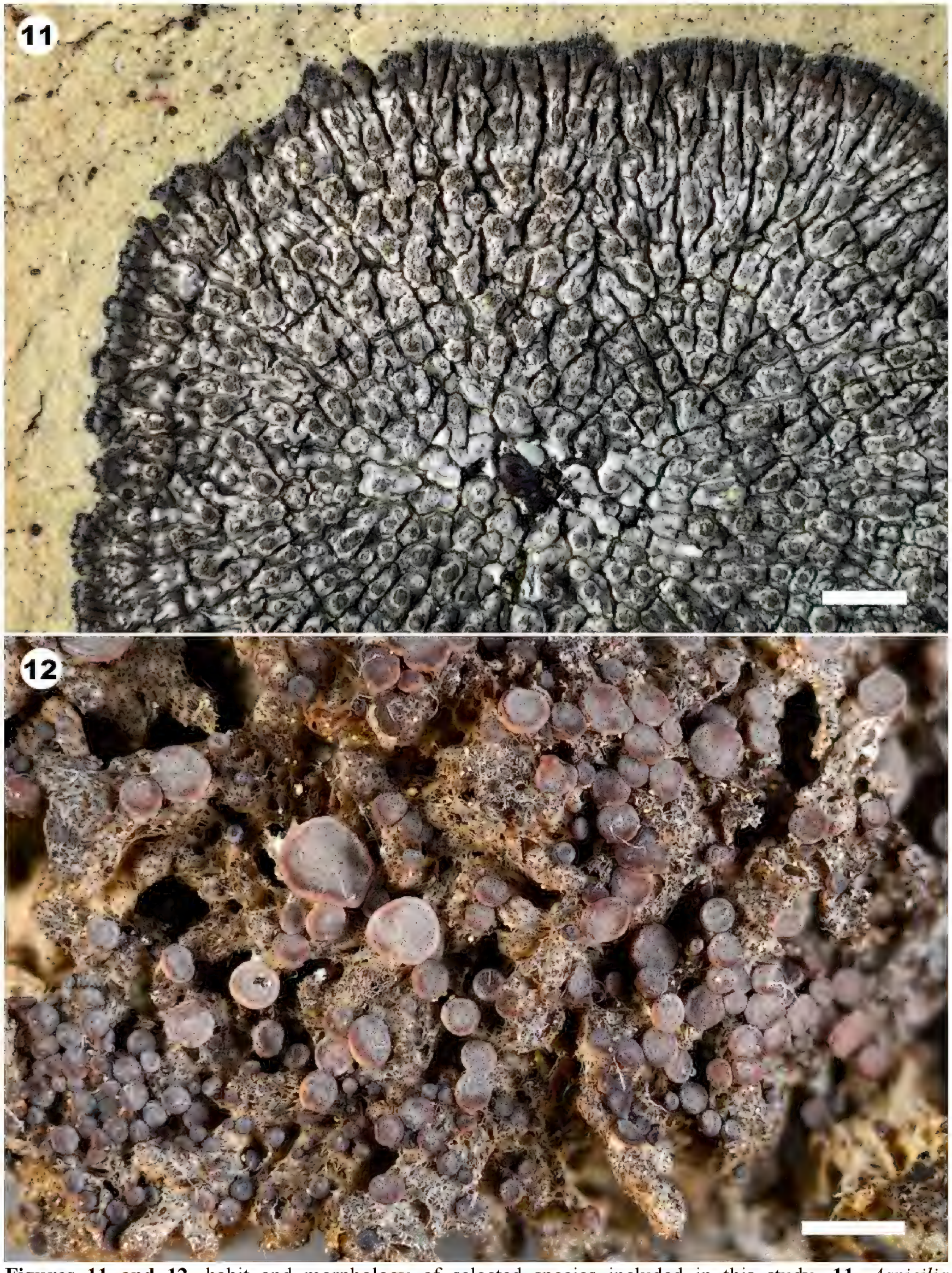
*Toninia.* – *Toninia tristis* currently comprises 11 subspecies (Timdal 1992, 2002). They are distinguished by a combination of chemotype (terpenoid pattern) and anatomical features (i.e., septation, size, and shape of the ascospores, pigment type in the epihymenium, and presence/absence of orange pigment in the cytoplasm of paraphyses, asci and ascospores). Timdal (1992: 20) discussed the choice of subspecific rank for the nine taxa he recognized at the time (two more were later introduced in Timdal 2002), and concluded that, although they appeared to be reproductively isolated, 'sibling', species, the problem in identifying them, which in most cases requires thin-layer chromatography and sometimes supplemented by microscopy, made the rank of subspecies most practical. Thirty more years of experience with this complex has consolidated our hypothesis that the subspecies are reproductively isolated and can always be identified by a combination of morphology and chemistry. Unfortunately, rather few DNA sequences are available, but so far four of the subspecies have been recovered in highly supported, long-branched clades in the ITS phylogeny (Fig. 9). The branch lengths of the four clades range from 4.2% (*T. tristis* ssp. *tristis*) to 14.6% (*T. tristis* ssp. *pseudotabacina*). While the remaining subspecies have yet to be sequenced, it is likely that they will similarly be recovered as strongly supported and monophyletic. Continuing to subsume these taxa as subspecies within a broadly delimited *T. tristis* obscures important biodiversity information. They are mostly ecological specialist taxa (e.g., soil crust lichens or restricted to limestone cliffs). We hence raise their ranks from subspecies to species here (see Appendix I).

## FLORISTIC AND TAXONOMIC SECTION

### **Aspicilia mashiginensis* (Zahlbr.) Oxner

**FIGURE 11.**

NOTES. – This species, described from Novaya Zemlya, is rarely reported from North America. There are four records in the CLH (2024) database (i.e., from California [1], Nunavut [1], and Greenland




**Figures 11 and 12**, habit and morphology of selected species included in this study. **11**, *Aspicilia mashiginensis* from Banff National Park (*Timdal 18072 & Rui*). **12**, *Bryonora septentrionalis*, from Banff National Park (*Timdal 18013 & Rui*). Scales = 1 mm.

[2]). It is not uncommon in northern Europe (Westberg et al. 2021), in our experience often growing on sloping rock faces near rivers but also in old mining areas. The species is recognized by the grayish to brownish, more or less effigurate thallus with capitate soralia in the center of the areoles. The original material in O contains substictic acid (Elix et al. 1987), but we have also examined specimens containing norstictic acid additionally or alternatively. The specimen from Alberta was found on stones on the ground in an alpine heath. It contains substictic acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1895°N, 117.1335°W, 2110 m. alt., on stones on the ground in the alpine region, *Arctostaphylos*/*Dryas* heath, 15.vii.2018, *E. Timdal 18072 & S. Rui* (O L-223717).

***Brodoa oroarctica* (Krog) Goward**

ITS SEQUENCE. – PQ279260.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8268°N, 118.1333°W, 2440 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18083 & S. Rui* (O L-223729).

****Bryonora septentrionalis* Holt.-Hartw.**

**FIGURE 12.**

ITS SEQUENCE. – MW927470.

NOTES. – This species was described from Norway by Holtan-Hartwig (1991) and was in the same publication reported also from a broad range of arctic and boreal regions in Europe (Finland, Sweden and Novaya Zemlya), Asia (arctic Russian mainland) and North America (Baffin Island, Canada and Greenland). There are two additional, apparently unpublished, North American records in the CLH (2024) database (i.e., from the Northwest Territories and British Columbia). The ITS sequence from our specimen was included in the *Bryonora* phylogeny of Svensson et al. (2022) but with the provenance given only as "Canada". Our specimen contains isousnic acid (by TLC) which is diagnostic for the species (Holtan-Hartwig 1991).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3283°N, 116.1788°W, 1860 m. alt., on bryophytes on rock wall, 11.vii.2018, *E. Timdal 18013 & S. Rui* (O L-223657).

***Buellia elegans* Poelt**

NOTES. – This soil crust lichen is represented by vouchers from three previous localities in Alberta in the CLH (2024) database and six in the ABMI (2024) database. One of our specimens accompanied *Caloplaca albosquamata*, another *Gypsoplaca rosulata*. All three specimens contain norstictic acid (by TLC).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Red Deer River, at Tolman Bridge, 51.8357°N, 113.0068°W, 720 m. alt., on soil, 07.vii.2018, *E. Timdal 18003 & S. Rui* (O L-223647); Kootenay Plains Ecological Reserve, 52.0422°N, 116.4178°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18030, S. Rui & T. Spribille* (O L-223674); N of Brulé Lake, picnic site ca. 1.1 km ENE of Solomon, 53.3393°N, 117.8197°W, 1060 m. alt., on soil in steep slope, exposed situation, 17.vii.2018, *E. Timdal 18097 & S. Rui* (O L-223742).

***Buellia epigaea* (Pers.) Tuck.**

**FIGURE 13.**

NOTES. – This soil crust lichen, which is apparently rare in North America (McCune 2017), was collected once and also observed without collecting at the type locality of *Caloplaca albosquamata*. There is only one previous in Alberta in the CLH (2024) database, i.e. north side of Bighorn Reservoir, *Tucker 9353A* (LSU 111879). Our specimen does not contain lichen substances (by TLC).

SPECIMEN EXAMINED. – Canada, Alberta, north of Brulé Lake, picnic site c. 1.1 km ENE of Solomon, 53.3393°N, 117.8202°W, 1060 m alt., on soil in steep slope, exposed situation, 2018-07-17, *E. Timdal 18092 & S. Rui* (O L-223738).

**Figure 13**. Habit and morphology of *Buellia epigaea* from Alberta, Canada (*Timdal 18092 & Rui*). Scale = 1 mm.

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*******Caloplaca albosquamata*** **Timdal & Rui, n. sp.**
Mycobank #855508

**FIGURE 14.**

Differs from other species of *Caloplaca* in the combination of being terricolous and in forming up to 3 mm wide, white pruinose squamules with marginal, gray soralia.

**TYPE: CANADA.** ALBERTA: Jasper National Park, between Edna Lake and Talbot Lake, 53.0827°N, 118.0282°W, 1050 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18053 & S. Rui* (O L-223700!, holotype).

DESCRIPTION. – Thallus squamulose, indeterminate; squamules more or less scattered, rounded, adnate, often with an irregular central depression, up to 3 mm diam., pale gray, dull, densely white pruinose, with a slightly thickened, straight to upturned margin. Soralia marginal, on the underside of upturned margin, gray; soredia up to 60 µm diam., globose, with a 10–12 µm thick wall of conglutinated hyphae. Upper cortex up to 70 µm thick, composed of anticlinally arranged, thin-walled hyphae with shortly cylindrical lumina (Fig. 14F), colorless or faintly gray at the base, densely filled by calcium oxalate crystals in upper half; algal layer 60–70 µm thick; photobiont green, unicellular algae, up to 15 µm diam.; medulla composed of loosely interwoven hyphae, non-amyloid, containing crystals of calcium oxalate; lower cortex absent. Apothecia and conidiomata unknown.

CHEMISTRY. – No lichen substances detected by TLC. All spot reactions negative.

ETYMOLOGY. – The species is named after the large, white pruinose squamules.

DNA SEQUENCES. – PQ279291 (ITS), PQ226160 (mtSSU).

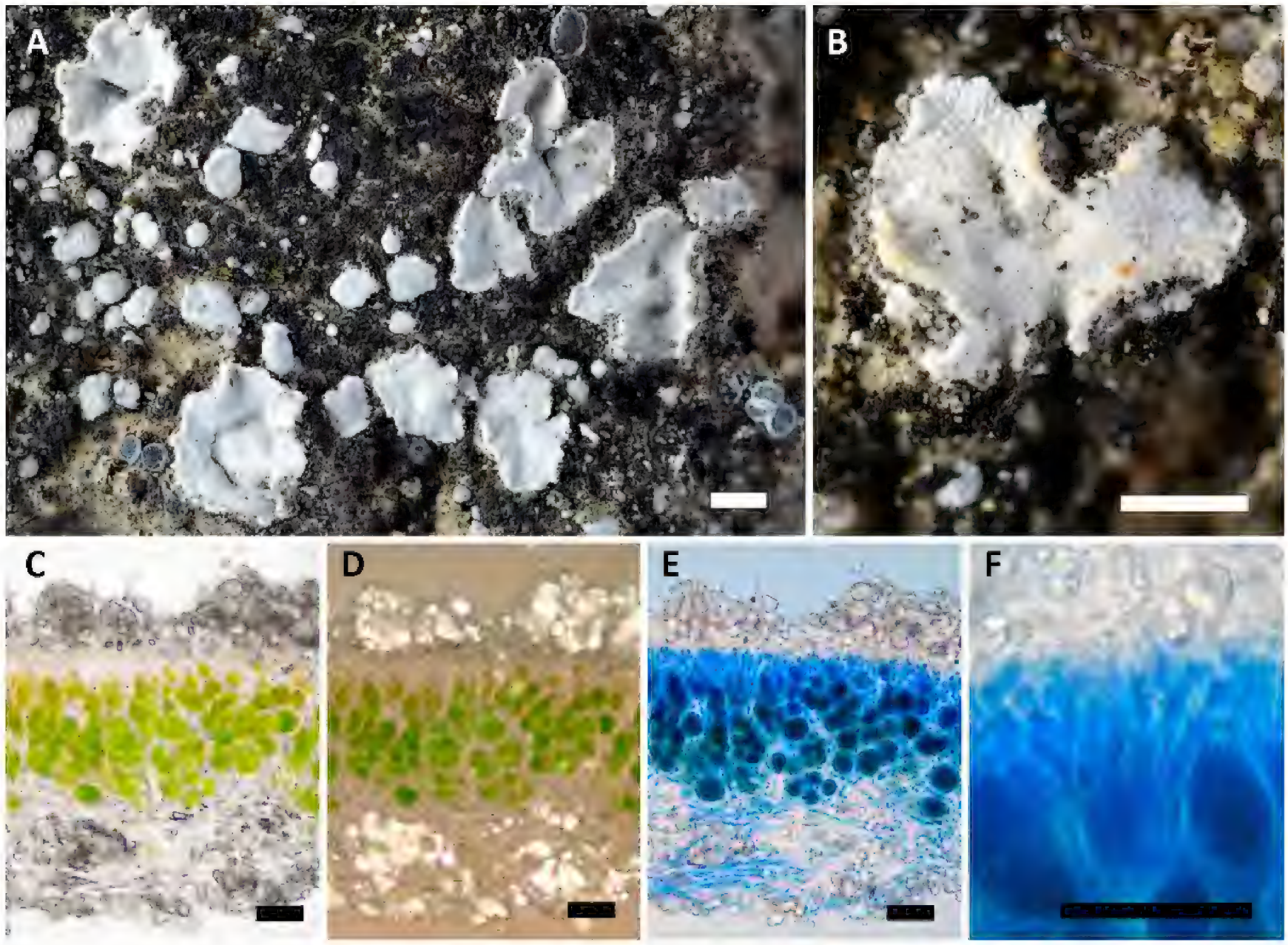


**Figure 14**. Morphology and anatomy of *Caloplaca albosquamata* from Jasper National Park (all from *Timdal 18053 & Rui*, holotype). **A**, habit and micromorphology. **B**, detail of squamule illustrating morphology of the soralia. **C**, section through thallus, mounted in water, viewed under normal light. **D**, section through thallus, mounted in water, viewed under polarized light, showing crystals of calcium oxalate. **E**, section through thallus, in mounted in LCB, viewed under normal light. **F**, section through upper cortex, mounted in LCB, viewed under normal light. Scales = 1 mm in A and B, 20 µm in C–F.

NOTES. – The large, white pruinose squamules and the marginal, gray soralia make the species unmistakable within *Caloplaca*. In fact, we did not even consider the Teloschistaceae as a likely taxonomic placement when collecting the material, but rather believed it represented *Trapeliopsis steppica*. That species differs in containing lecanoric acid (the thallus is C+ red; McCune et al. 2002) and apparently in forming more contiguous, sometimes slightly lobate squamules which are less pruinose and lacking a central depression. This is yet another example of the problem of placing a non-fertile lichen in the taxonomical hierachy without molecular data; see, e.g., the similar cases of *Caloplaca reptans* Lendemer & B.P. Hodk. (Hodkinson & Lendemer 2012) and *Lecanora carpoides* Timdal (Timdal 2001a).

The species was found in a well-developed soil crust community in a small hillside in open habitat. It was fairly common at the site. Associated species included *Buellia epigaea*, *Gyalidea asteriscus* (Anzi) Aptroot & Lücking, *Gyalolechia fulgens* (Sw.) Søchting et al., *Psora decipiens* (Hedw.) Hoffm., *P. vallesiaca*, *Squamarina lentigera* (Weber) Poelt, and *Thalloidima physaroides*.

******Calvitimela melaleuca* **(Sommerf.) M.P. Andreev**

DNA SEQUENCES. – OR763906 (ITS, O L-223724), OR738359 (MCM7, O L-223724), OR738397 (TEF1-α, O L-223724), OR763925 (ITS, O L-223736), OR738406 (TEF1- α, O L-223736).

NOTES. – The sequences from our two specimens were included in the *Calvitimela* phylogeny of Fjelde et al. (2023), but with the provenance given as "Canada", only. In that phylogeny, *C. melaleuca* was recovered as polyphyletic and the specimens from Alberta were recovered in the clade named "*C. melaleuca* II". Both our specimens contain alectorialic acid and rangiformic acid; O L-223736 also produced psoromic acid and norrangiformic acid in addition to those substances (by TLC).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8300°N, 118.1250°W, 2360 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18080 & S. Rui* (O L-223724); Jasper National Park, Mount Whistler, 52.8265°N, 118.1330°W, 2450 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18090 & S. Rui* (O L-223736).

***Dactylina arctica* (Hook.) Nyl.**

NOTES. – The specimen contains gyrophoric acid and usnic acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3283°N, 116.1788°W, 1860 m. alt., on bryophytes on rock wall, 11.vii.2018, *E. Timdal 18014 & S. Rui* (O L-223658).

***Dactylina ramulosa* (Hook.) Nyl.**

NOTES. – Both specimens contain physodic acid, and O L-223713 also contained usnic acid (by TLC).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3282°N, 116.1768°W, 1850 m. alt., among bryophytes on slope by trail in conifer forest, 11.vii.2018, *E. Timdal 18017 & S. Rui* (O L-223661); Banff National Park, Parker Ridge, above Hilda Creek, 52.1875°N, 117.1272°W, 2160 m. alt., on the ground in the alpine region, 15.vii.2018, *E. Timdal 18069a & S. Rui* (O L-223713).

*****Elixia praeruptorum* Timdal & Rui, n. sp.**

Mycobank #855509

**FIGURE 15.**

Differs from the two other species of *Elixia* in forming orbicular to slightly ellipsoid or irregular apothecia, in containing norstictic acid in thallus and apothecia, and in growing on rock.

**TYPE: CANADA.** ALBERTA: Jasper National Park, picnic site between Medicine Lake and Maligne Lake, 52.7708°N, 117.6865°W, 1610 m. alt., on vertical to overhanging face of boulder in boulder scree, 13.vii.2018, *E. Timdal 18043 & S. Rui* (O L-223687!, holotype).

DESCRIPTION. – Thallus areolate, indeterminate; areolae up to 0.4 (–0.5) mm diam., medium to dark brown, shiny, with a dark grey to black, slightly thickened margin, scattered or rarely contiguous, rounded, plane to slightly concave; hypothallus well developed, black; upper cortex 60–100 µm thick, including an up to 60 µm thick epinecral layer, composed of mainly anticlinally oriented, rather thin-walled hyphae with isodiametrical or shortly cylindrical lumina (Fig. 15E), with a brown pigment zone in the upper part of the living layer and with crystals of norstictic acid partly in the pigment zone and partly in the lower part of the epinecral layer (Fig. 15D), containing remnants of dead algae throughout the cortex (Chlor-Zinc-Iodine); algal layer 40–60 µm, continuous, with strands of crystals of norstictic acid; photobiont unicellular green algae, up to 14 µm diam.; medulla poorly developed, KI–, containing crystals of norstictic acid; lower cortex absent. Apothecia up to 0.2 (–0.3) mm diam., attached to the hypothallus or to the margin of the areolae, black, epruinose, slightly shiny, orbicular when young, often becoming slightly elongated or irregular, plane to moderately concave, with a smooth or sometimes umbonate disc, with a well-developed, persistent, black margin; excipulum green (K–) laterally to the hymenium and reddish brown (K–) below the hymenium, turning blackish towards the rim, containing crystals dissolving in K with a yellow effusion and recrystallizing by forming red, needle-shaped crystals (norstictic acid), composed of conglutinated, rather thin-walled hyphae with ellipsoid to shortly cylindrical lumina (Fig. 15F–H); hypothecium colourless or faintly green, K–; hymenium colourless to faintly green, amyloid; epihymenium dark green, K–, not containing crystals; asci ovate to shortly clavate, with a thin, amyloid tholus which is lacking deeper amyloid structures and ocular chamber (Fig. 15I, J); ascospores 8 per ascus, simple, hyaline, broadly ellipsoid to subglobose, 7–9 × 4–6 µm (n = 20). Conidiomata not seen.

CHEMISTRY. – Norstictic acid (by TLC), located in medulla, upper cortex, and excipulum (by polarized light and K reaction); upper cortex, medulla and exciple PD+ yellow; K+ yellow, turning red; C–, KC–.

ETYMOLOGY. – The species is named after the habitat: vertical to overhanging rock walls.

**Figure 15**. Morphology and anatomy of *Elixia praeruptorum* from Jasper National Park (all from *Timdal 18043 & Rui*, holotype). **A**, habitus and macromorphology. **B**, detail of areolae and apothecia. **C**, section through thallus, mounted in LCB, viewed under normal light. **D**, section through thallus, mounted in LCB, viewed under polarized light, showing crystals of norstictic acid. **E**, section through upper cortex, mounted in LCB, viewed under normal light. **F**, section through apothecium, mounted in water, viewed under normal light. **G**, section through apothecium, mounted in water, viewed under polarized light, showing crystals of norstictic acid. **H**, section through excipulum, mounted in LCB, viewed under normal light. **I and J**, asci, mounted in modified Lugol's solution after pretreatment in K, viewed under normal light. Scales = 1 mm in A, 0.2 mm in B, 100 µm in C, D, F & G, and 10 µm in E, H–J.

**Figure 16**. Habitat of *Elixia praeruptorum* at the type locality in Jasper National Park. The holotype was collected from the vertical to overhanging face near the center of the image.

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SEQUENCES. – PQ279269 (ITS), PQ226159 (mtSSU).

NOTES. – From the description and photograph in Stone (2013: 13) the sequenced voucher *Stone 8170* is a brown, areolate, saxicolous lichen with black, lecideine apothecia, having ascospores ca. 7.5 × 6–6.5 µm, and containing norstictic acid. It clearly matches the description of the holotype.

The holotype was collected from a vertical to overhanging face of a boulder in an open, SW-facing boulder scree in conifer forest (Fig. 16).

ADDITIONAL SPECIMEN, IDENTIFIED BY ITS SEQUENCE ONLY. – **U.S.A.** OREGON. JACKSON CO.: Evans Creek area, Rattlesnake Rocks, UTM (NAD83): 10T 0509305 4721890 [= 42.6494°N, 122.8865°W], 975 m. alt., tall andesite cliffs facing E, S and W in a mixed conifer forest, andesite, 04.iv.2011, *D. Stone 8170* (OSC 164195).

***Fulgidea oligospora* (Timdal) Bendiksby & Timdal**

**FIGURE 17A.**

NOTES. – There is one previous record from Alberta in the CLH (2024) database (east Alberta, Saskatchewan River Plains, *C. Björk 32125*, UBC L48608) and 31 occurences indicated on the map in the ABMI (2024) database. Our specimen contains alectorialic and thamnolic acid (by TLC).

SPECIMEN EXAMINED. – Canada, Alberta, Banff CANADA. ALBERTA: Banff National Park, Bow Valley Parkway, forest trail from parking lot ca. 1.6 km NW of crossing of Johnston Canyon, 51.2600°N, 115.8575°W, 1470 m. alt., on burnt stump in confer forest, 10.vii.2018, *E. Timdal 18011 & S. Rui* (O L-223655).

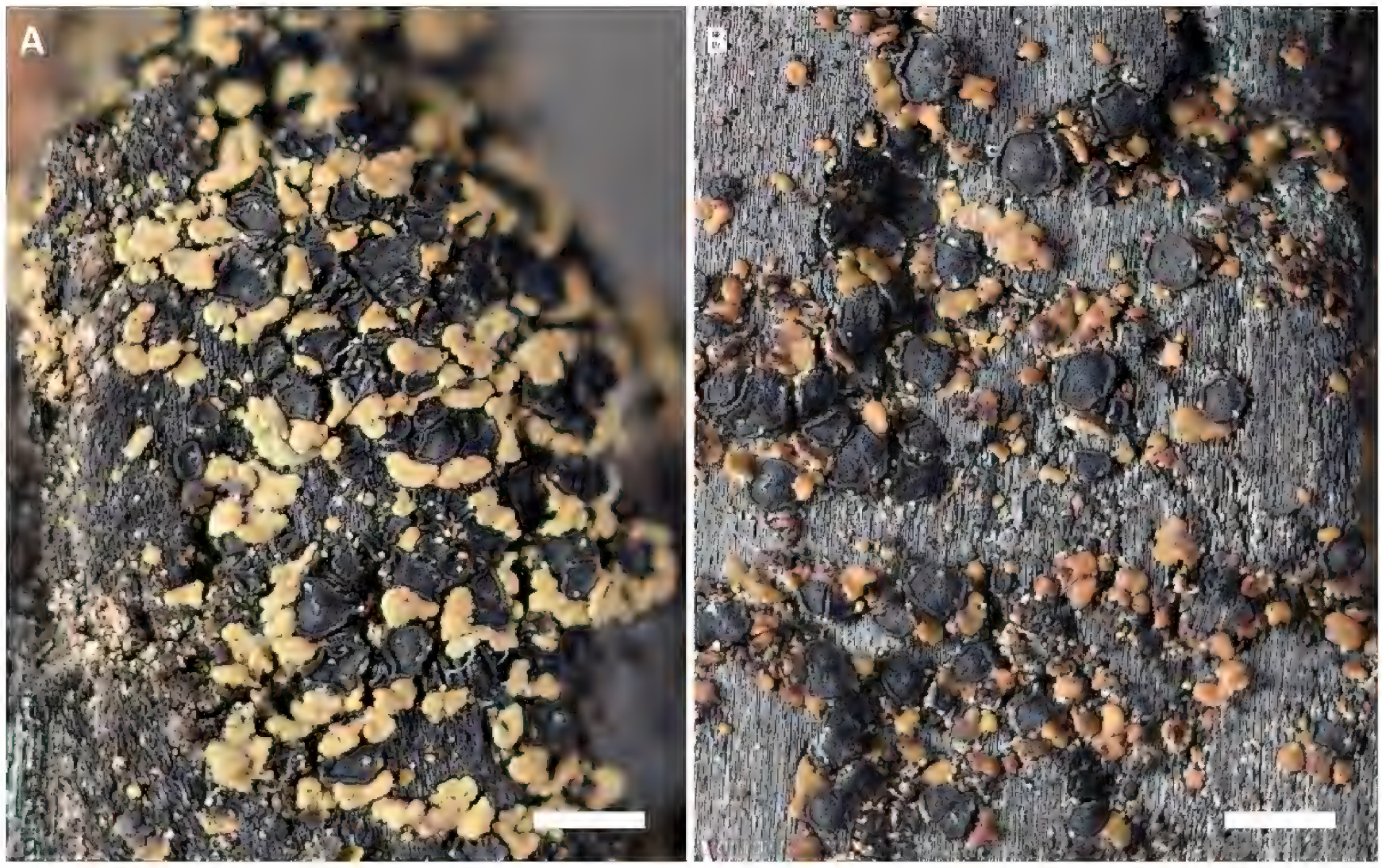



**Figure 17**. Habit and morphology of selected species included in this study. **A**, habit and micromorphology of *Fulgidea oligospora* from Banff National Park (*Timdal 18011 & Rui*). **B**, habit and micromorphology *Xylopsora friesii*, from Banff National Park (*Timdal 18012 & Rui*). Scales = 1 mm.

***Gyalidea asteriscus* (Anzi) Aptroot & Lücking**

**FIGURE 18.**

NOTES. – This soil crust lichen is represented by a single previous locality in Alberta in the CLH (2024) database (N side of Bighorn Reservoir, *S.C. Tucker 9355*, LSU 159872). Our specimen is from the *Caloplaca albosquamata* type locality.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, between Edna Lake and Talbot Lake, 53.0828°N, 118.0287°W, 1040 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18050 & S. Rui* (O L-223697).

***Gyalolechia fulgens* (Sw.) Søchting, Frödén & Arup**

**FIGURE 19.**

ITS SEQUENCE. – PQ279292.

NOTES. – Like the previous species, *Gyalolechia fulgens* was found at the type locality of *Caloplaca albosquamata*. It is represented by a single previous apparently unpublished occurrence in Alberta in the CLH (2024) database (Whitehorse Lake, SE Alberta, *J. Looman 632203*, WIS L-0056013). The ITS sequence matches the 16 sequences of *G. fulgens* in GenBank with a similarity ranging from 98.2 to 100% (BLASTn).

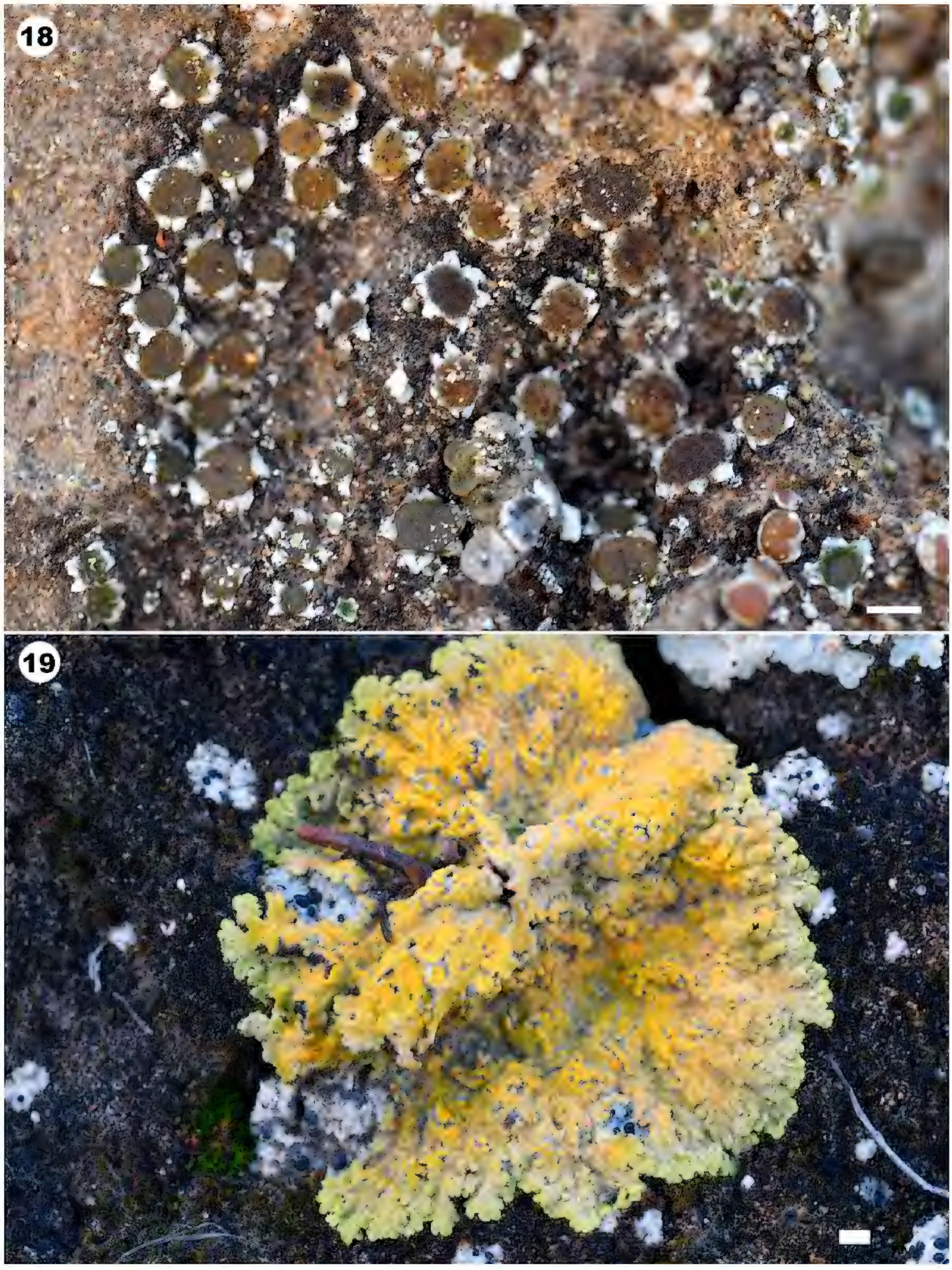
SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, between Edna Lake and Talbot Lake, 53.0827°N, 118.0287°W, 1040 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18052 & S. Rui* (O L-223699).

***Gypsoplaca rosulata* H.X. Shi, Li S. Wang & Timdal**

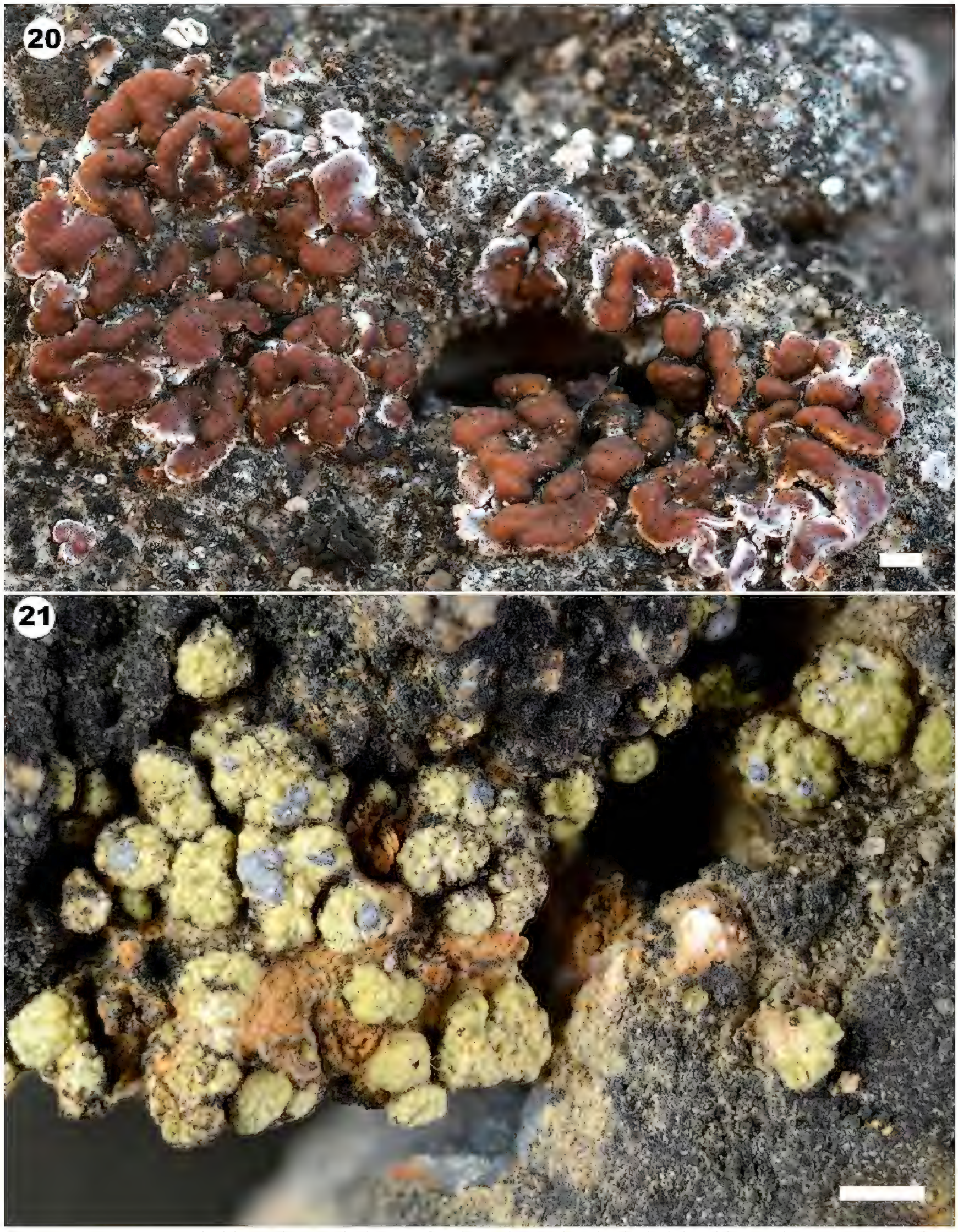
**FIGURE 20.**

ITS SEQUENCES. – PQ279253 (O L-223677), PQ279255 (O L-223740).

NOTES. – The ITS sequences of the two specimens from Alberta were recovered in the *Gypsoplaca rosulata* clade (Fig. 7). The specimens belong to the most common North American chemotype (Fig. 10).




**Figures 18 and 19**, habit and morphology of selected species included in this study. **18**, *Gyalidea asteriscus*, from Jasper National Park (*Timdal 18050 & Rui*). **19**, *Gyalolechia fulgens*, from Jasper National Park (*Timdal 18052 & Rui*). Scales = 1 mm.




**Figures 20 and 21**, habit and morphology of selected species included in this study. **20**, *Gypsoplaca rosulata*, from near Solomon, Alberta (*Timdal 18095 & Rui*). **21**, *Kiliasia sculpturata*, from Jasper National Park, *Timdal 18057 & Rui*). Scales = 1 mm.

**Figure 22**. Habitat of *Kiliasia sculpturata* where the species was collected in Jasper National Park. The species was found on the vertical rock face in the foreground.

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SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0422°N, 116.4185°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18033, S. Rui & T. Spribille* (O L-223677); N of Brulé Lake, picnic site ca. 1.1 km ENE of Solomon, 53.3393°N, 117.8197°W, 1060 m. alt., on soil in steep slope, exposed situation, 17.vii.2018, *E. Timdal 18095 & S. Rui* (O L-223740).

***Hypocenomyce scalaris* (Ach.) M. Choisy**

NOTES. – The species grew on a burnt stump together with *Fulgidea oligospora*. The specimen contains lecanoric acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Bow Valley Parkway, forest trail from parking lot ca. 1.6 km NW of crossing of Johnston Canyon, 51.2600°N, 115.8575°W, 1470 m. alt., on burnt stump in confer forest, 10.vii.2018, *E. Timdal 18010 & S. Rui* (O L-223654).

****Kiliasia sculpturata* (H. Magn) Kistenich, Timdal, Bendiksby & S. Ekman**

**FIGURE 21.**

ITS SEQUENCE. – PQ279264.

NOTES. – The species is known from a few scattered occurrences in arid parts of Europe, Asia, and North America (Timdal 1992, Timdal & Zhurbenko 1995; as *Toninia sculpturata* [H. Magn.] Timdal). In North America, it was previously known from Arizona, Colorado, and Utah (Timdal 1992, 2002). The pale yellow thallus and bluish white pruinose apothecia make the species unmistakable. Our specimen was found very sparingly on vertical to overhanging faces of an exposed limestone cliff in confer forest near the base of a hillside (Fig. 22). The ITS sequence matches the two ITS sequences of *Kiliasia sculpturata* in GenBank, AF282110 and MG926034, with 96.8 and 97.6% similarities, respectively (values from BLASTn).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, S end of Talbot Lake, 53.0860°N, 118.0253°W, 1040 m. alt., on vertical to overhanging face of limestone wall, 14.vii.2018, *E. Timdal 18057 & S. Rui* (O L-223704).

***Lecanora atromarginata* (H. Magn.) Hertel & Rambold**

ITS SEQUENCE. – PQ279294.

NOTES. – The species is listed in Alberta by Environment and Parks (2022, as *Lecidea atromarginata* H. Magn.), but there are no records from Alberta in the CLH (2024) database. Our sequence matches MZ502325, the only sequence of *L. atromargianta* in GenBank, with 97.1% similarity (value from BLASTn).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1895°N, 117.1335°W, 2110 m. alt., on stones on the ground in the alpine region, *Arctostaphylos/Dryas* heath, 15.vii.2018, *E. Timdal 18071 & S. Rui* (O L-223716).

****Lecanora neodegelii* B.D. Ryan & T.H. Nash**

ITS SEQUENCE. – PQ279254.

NOTES. – The species was described as *Squamarina degelii* Poelt (Poelt 1958) from an islet just outside Oslo, Norway. There are no sequences of the species in GenBank, but two unpublished ITS sequences from Norway produced by the OLICH project match our sequence from Alberta with 96.3 and 97.2% similarity (values from BLASTn). The specimen contains usnic acid; no traces of fatty acids were detected (by TLC).

There is only one collection of the species from Canada in the CLH (2024) database (i.e., Alberta, 25 km N of Twin Buttes, *B.D. Ryan 13926*, ASU barcode 547387). The identity of Ryan's collection was questioned by McCune (2017), and it is not listed from Alberta in either Environment and Parks (2022) or NatureServe (2024). We here confirm the occurrence of the species in Alberta and Canada.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Red Deer River, Dry Island Buffalo Jump Provincial Park, 51.9370°N, 112.9630°W, 720 m. alt., on boulder, 08.vii.2018, *E. Timdal 18004, S. Rui & T. Spribille* (O L-223648).

***Lecanora polytropa* (Ehrh. ex Hoffm.) Rabenh.**

ITS SEQUENCES. – PQ279286 (O L-223653), PQ279287 (O L-223737).

NOTES. – The species was shown to be phylogenetically very heterogeneous by Zhang et al. (2022). The ITS sequence of our specimen from Banff is 100% similar (value from BLASTn; 512 bp alignment) to their putative species "po23" (a singleton from Utah, GenBank No. ON180104), and the sequence of our specimen from Jasper was recovered in clade "po10" (represented by sequences generated from vouchers collected at multiple sites in North America) in a phylogenetic reconstruction (not shown).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Bow Valley Parkway, parking lot ca. 1.6 km NW of crossing of Johnston Canyon, 51.2570°N, 115.8573°W, 1440 m. alt., on impregnated wood by parking lot, 10.vii.2018, *E. Timdal 18009 & S. Rui* (O L-223653); Jasper National Park, Mount Whistler, 52.8265°N, 118.133°W, 2450 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18091 & S. Rui* (O L-223737).

***Lecidea atrobrunnea* (Ramond ex Lam. & DC.) Schaer.**

ITS SEQUENCES. – PQ279277 (O L-223666), PQ279259 (O L-223709).

NOTES. – Specimens O L-223666 and O L-223735 contain 2'-O-methylperlatolic acid (by TLC). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3188°N, 116.1563°W, 1960 m. alt., on boulder in boulder field near lake, 11.vii.2018, *E. Timdal 18022 & S. Rui* (O L-223666); Banff National Park, Parker Ridge, above Hilda Creek, 52.1887°N, 117.1302°W, 2125 m. alt., on rock in the alpine region, 15.vii.2018, *E. Timdal 18065 & S. Rui* (O L-223709); Jasper National Park, Mount Whistler, 52.8268°N, 118.1355°W, 2420 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18089 & S. Rui* (O L-223735).

***Lecidea lapicida* (Ach.) Ach.**

ITS SEQUENCES – PQ279252 (O L-223722), PQ279265 (O L-223733).

NOTES. – The two specimens contain stictic acid (by TLC). The species was reported from Jonas Rockslide, Jasper National Park by John (1989).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Icefields Parkway, ca. 1.6 km N of Jonas Creek, 52.4312°N, 117.4073°W, 1610 m. alt., on boulders in boulder field, 15.vii.2018, *E. Timdal 18078 & S. Rui* (O L-223722); Jasper National Park, Mount Whistler, 52.827°N, 118.1355°W, 2420 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18087 & S. Rui* (O L-223733).

***Lecidea tessellata* Flörke**

ITS SEQUENCES – PQ279251 (O L-223715), PQ279280 (O L-223721).

NOTES. – The two specimens contain confluentic acid (major) and undetermined compounds (minor) (by TLC). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1875°N, 117.1273°W, 2160 m. alt., on stones on the ground in the alpine region, 15.vii.2018, *E. Timdal 18070 & S. Rui* (O L-223715); Jasper National Park, Icefields Parkway, ca. 1.6 km N of Jonas Creek, 52.4312°N, 117.4077°W, 1610 m. alt., on boulders in boulder field, 15.vii.2018, *E. Timdal 18077 & S. Rui* (O L-223721).

***Orphniospora moriopsis* (A. Massal.) D. Hawskw.**

NOTES. – The species is listed from Alberta in Environment and Parks (2022) and NatureServe (2024), but there are no previous records in the CLH (2024) database. It was also reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8275°N, 118.1278°W, 2420 m. alt., on big boulder in the alpine region, 16.vii.2018, *E. Timdal 18082a & S. Rui* (O L-223726).

***Peltigera aphthosa* (L.) Willd.**

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along Sunshine Road, 51.1308°N, 115.7098°W, 1590 m. alt., on the ground in conifer forest, 10.vii.2018, *E. Timdal 18008 & S. Rui* (O L-223652); Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3283°N, 116.1785°W, 1860 m. alt., on the ground in conifer forest, 11.vii.2018, *E. Timdal 18015 & S. Rui* (O L-223659), *E. Timdal 180156 & S. Rui* (O L-223660).

***Psora cerebriformis* W.A. Weber**

NOTES. – There is only one previous record of this species from Alberta in the CLH database (2024) (i.e., 1 km E of Whirpool Point, *B. Goffinet 126*, CONN barcode 01002558). The location where that voucher was collected is approximately five kilometers south-southwest of our site. There is one additional record in ABMI (2024).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0422°N, 116.4177°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18028, S. Rui & T. Spribille* (O L-223672).

***Psora decipiens* (Hedw.) Hoffm.**

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Red Deer River, at Tolman Bridge, 51.8355°N, 113.0067°W, 720 m. alt., on soil, 07.vii.2018, *E. Timdal 18002 & S. Rui* (O L-223646); Kootenay Plains Ecological Reserve, 52.0447°N, 116.4257°W, 1370 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18039, S. Rui & T. Spribille* (O L-223684); Jasper National Park, between Edna Lake and Talbot Lake, 53.0823°N, 118.0283°W, 1050 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18054 & S. Rui* (O L-223701).

***Psora nipponica* (Zahlbr.) Gotth. Schneid.**

ITS SEQUENCE. – PQ279272.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Athabasca Falls, 52.6648°N, 117.8848°W, 1170 m. alt., on rock outcrop in slope towards the river, 14.vii.2018, *E. Timdal 18047c & S. Rui* (O L-223693).

***Psora vallesiaca* (Schaer.) Timdal**

ITS SEQUENCES. – PQ202350 (O L-223739), PQ202334 (O L-223698).

NOTES. – This species resembles terricolous forms of *Psora himalayana* (C. Bab.) Timdal, but differs in containing norstictic acid (Timdal 1986). ITS sequences reveal that specimens of *P. vallesiaca* may lack norstictic acid, and the taxonomy of those species is now under study. Our two sequences from Alberta are identical, and also identical to three European sequences of *P. vallesiaca* (KU873926, KU873927, KU873931). The specimens O L-223676 and O L-223739 contain norstictic acid, the third specimen (O L-223698) is acid deficient. The species was previously known in North America from Greenland and Nunavut (Timdal 1986).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0422°N, 116.4182°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18032, S. Rui & T. Spribille* (O L-223676); Jasper National Park, between Edna Lake and Talbot Lake, 53.0828°N, 118.0287°W, 1040 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18051 & S. Rui* (O L-223698); N of Brulé Lake, picnic site ca. 1.1 km ENE of Solomon, 53.3393°N, 117.8200°W, 1060 m. alt., on soil in steep slope, exposed situation, 17.vii.2018, *E. Timdal 18093 & S. Rui* (O L-223739).

***Rhizocarpon bolanderi* (Tuck.) Herre**

ITS SEQUENCE. – PQ219489.

NOTES. – The species is recognized by the brown, gray-edged, slightly peltate areolae, the two-spored asci, and the muriform, brown ascospores (Feuerer & Timdal 2004). Our specimen contains stictic acid (by TLC). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3187°N, 116.1562°W, 1960 m. alt., on boulder in boulder field near lake, 11.vii.2018, *E. Timdal 18021 & S. Rui* (O L-223665).

***Rhizocarpon disporum* (Nägeli ex Hepp) Müll.Arg.**

ITS SEQUENCE. – PQ219487.

NOTES. – The species is recognized by the gray, sometimes brownish, areolae, single-spored asci, and muriform, brown ascospores (Feuerer & Timdal 2004). Our specimen does not contain lichen substances (by TLC). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Red Deer River, Dry Island Buffalo Jump Provincial Park, 51.9370°N, 112.9637°W, 720 m. alt., on boulder, 08.vii.2018, *E. Timdal 18005, S. Rui & T. Spribille* (O L-223649).

***Rhizocarpon effiguratum* (Anzi) Th. Fr.**

DNA SEQUENCES. – PQ219499 (ITS), ON324016 (mtSSU).

NOTES. – The species is recognized by the yellow areolae which are often slightly effigurate at the margin, weakly amyloid medulla, small (12–18 × 5–10 µm), 1-septate, brown ascospores, and the autonomous or lichenicolous (on *Pleopsidium*) life habit (Feuerer & Timdal 2004). It is listed from Alberta in Environment and Parks (2022) and NatureServe (2024), but there are no previous records from Alberta in the CLH (2024) database. That database contains only three Canadian records, one each from British Columbia, Nunavut, and Québec. The mtSSU sequence from our specimen was published by Halıcı et al. (2022). Our specimen is autonomous and contains psoromic acid and rhizocarpic acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8272°N, 118.1357°W, 2410 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18085 & S. Rui* (O L-223731).

***Rhizocarpon geminatum* Körb.**

ITS SEQUENCE. – PQ219493.

NOTES. – The species is recognized by the gray, sometimes brownish, areolae, two-spored asci, and muriform, brown ascospores (Feuerer & Timdal 2004). Our specimens contain stictic acid (major) and norstictic acid (minor) (by TLC). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Athabasca Falls, 52.665°N, 117.8847°W, 1170 m. alt., on vertical rock wall near road, 14.vii.2018, *E. Timdal 18047a & S.*

*Rui* (O L-223691); Banff National Park, Parker Ridge, above Hilda Creek, 52.1887°N, 117.1302°W, 2125 m. alt., on rock in the alpine region, 15.vii.2018, *E. Timdal 18066 & S. Rui* (O L-223710).

***Rhizocarpon geographicum* (L.) DC.**

ITS SEQUENCES. – PQ219488 (O L-223664), PQ219494 (O L-223711), PQ219500 (O L-223732).

NOTES. – The species is recognized by the yellow areolae, amyloid medulla, medium-sized (20–36 × 10–20 µm), muriform, brown ascospores, and autonomous life habit (Feuerer & Timdal 2004). Our three specimens contain psoromic acid and rhizocarpic acid (by TLC).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3183°N, 116.1555°W, 1960 m. alt., on boulder in boulder field near lake, 11.vii.2018, *E. Timdal 18020 & S. Rui* (O L-223664); Banff National Park, Parker Ridge, above Hilda Creek, 52.1887°N, 117.1302°W, 2125 m. alt., on rock in the alpine region, 15.vii.2018, *E. Timdal 18067 & S. Rui* (O L-223711); Jasper National Park, Mount Whistler, 52.8270°N, 118.1355°W, 2420 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18086 & S. Rui* (O L-223732).

***Rhizocarpon grande* (Flörke) Arnold**

ITS SEQUENCE. – PQ219497 (O L-223720).

NOTES. – The species is recognized by the gray or brown areolae, slightly amyloid medulla giving a C+red reaction (gyrophoric acid), eight-spored asci, and muriform, brown ascospores (Feuerer & Timdal 2004). The species was reported from Jonas Rockslide in Jasper National Park by John (1989).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3298°N, 116.1733°W, 1860 m. alt., on boulder in shady conifer forest, 11.vii.2018, *E. Timdal 18018 & S. Rui* (O L-223662); Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3280°N, 116.1782°W, 1860 m. alt., on overhanging rock wall by trail in open conifer forest, 11.vii.2018, *E. Timdal 18025 & S. Rui* (O L-223669); Jasper National Park, Icefields Parkway, ca. 1.6 km N of Jonas Creek, 52.4312°N, 117.4077°W, 1610 m. alt., on boulders in boulder field, 15.vii.2018, *E. Timdal 18076 & S. Rui* (O L-223720).

***Rhizocarpon intermediellum* Räsänen**

ITS SEQUENCES. – PQ219498 (O L-223725), PQ219501 (O L-223734).

NOTES. – The species is recognized by the yellow areolae, amyloid medulla, small (16–23 × 7–10 µm), (1–)3-septate (–submuriform), brown ascospores, and the early to persistent lichenicolous life habit (on *Aspicilia, Lecidea*, and other crustose, saxicolous lichens) (Fryday et al. 2024, Holtan-Hartwig & Timdal 1987). There are two previous collections from Alberta in the CLH (2024) database (Bow River Watershed, Pyriform Mountain, *C.D. Bird 11800*, WIS L0094930; Banff National Park, Snow Creek Pass, *W.A. Weber s.n.*, COLO L-0039839). Specimen O L-223725 is autonomous and contains rhizocarpic acid only (by TLC).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8297°N, 118.1245°W, 2370 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18081 & S. Rui* (O L-223725); Jasper National Park, Mount Whistler, 52.8268°N, 118.1355°W, 2420 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18088 & S. Rui* (O L-223734).

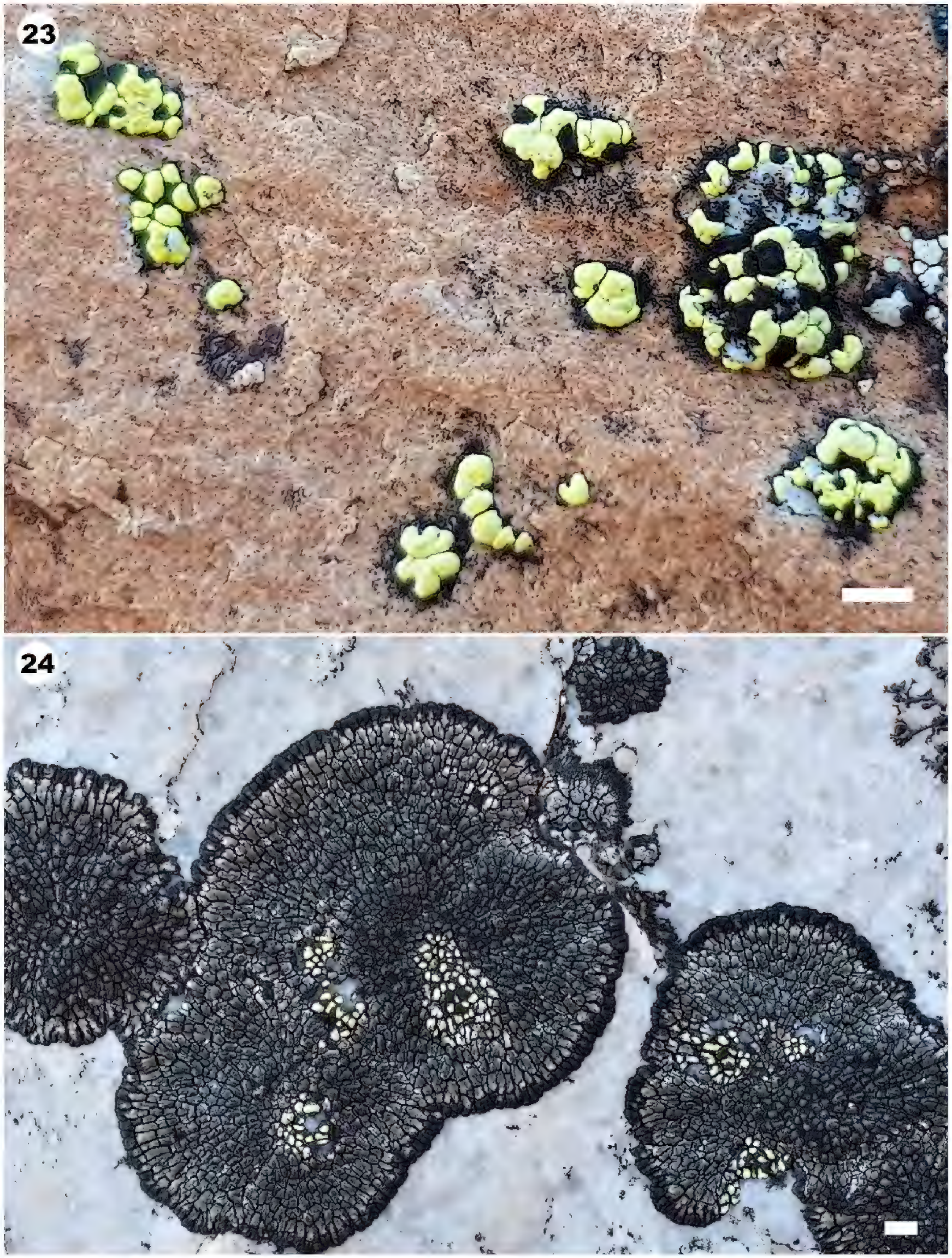
****Rhizocarpon norvegicum* Räsänen**

**FIGURE 23.**

ITS SEQUENCE. – PQ219495.

NOTES. – The species is recognized by the small (usually up to 5 mm diam.) thallus consisting of yellow areolae, amyloid medulla, small (9–15 × 6–7 µm), 1-septate, brown ascospores, and the early lichenicolous (mainly on *Acarospora*) life habit (Holtan-Hartwig & Timdal 1987, Runemark 1956). In Canada, the species is previously known from four, possibly unpublished collections in British Columbia (1), Nunavut (2), and the Northwest Territories (1) (CLH 2024).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1875°N, 117.1267°W, 2160 m. alt., on stone on the ground in the alpine region, 15.vii.2018, *E. Timdal 18068 & S. Rui* (O L-223712).




**Figures 23 and 24**, habit and morphology of selected species included in this study. **23**, *Rhizocarpon norvegicum*, from Banff National Park (*Timdal 18068 & Rui*). **24**, *Rhizocarpon pusillum*, from Banff National Park, *Timdal 18073 & Rui*). Scales = 1 mm.

***Rhizocarpon pusillum* Runemark**

**FIGURE 24.**

ITS SEQUENCE. – PQ219496.

NOTES. – The species is recognized by the small (usually up to 10 mm diam.) thallus consisting of yellow areolae, non-amyloid medulla, small (9–15 × 6–7 µm), 1-septate, brown ascospores, and the persistent lichenicolous life habit (on *Sporastatia testudinea*) (Feuerer & Timdal 2004). It is listed from Alberta in Environment and Parks (2022) and NatureServe (2024), but there are no previous records from Alberta in the CLH (2024) database.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1895°N, 117.1335°W, 2110 m. alt., on stones on the ground in the alpine region, *Arctostaphylos/Dryas* heath, on *Sporastatia testudinea*, 15.vii.2018, *E. Timdal 18073 & S. Rui* (O L-223718).

***Rhizocarpon superficiale* (Schaerer) Vainio**

DNA SEQUENCES. – ON332061 (ITS), ON324017 (mtSSU).

NOTES. – The species is recognized by the yellow areolae, non-amyloid medulla, small (14–18 × 6–8 µm), 1-septate, brown ascospores, and autonomous life habit (Feuerer & Timdal 2004). There is only one previous record from Alberta in the CLH (2024) database (i.e., Banff National Park, Consolation Lake Trail, NE of Moraine Lake, *B.D. Ryan 14125*, ASU barcode 572196). The species was reported from Jonas Rockslide in Jasper National Park by John (1989). The two sequences obtained from our specimen were published by Halıcı et al. (2022). Our specimen contains norstictic acid and rhizocarpic acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1895°N, 117.1335°W, 2110 m. alt., on stones on the ground in the alpine region, 15.vii.2018, *E. Timdal 18074 & S. Rui* (O L-223719).

***Schaereria fuscocinerea* (Nyl.) Clauzade & Cl. Roux**

ITS SEQUENCE. – PQ279261.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8275°N, 118.1278°W, 2420 m. alt., on big boulder in the alpine region, 16.vii.2018, *E. Timdal 18082c & S. Rui* (O L-223728).

***Solorina crocea* (L.) Ach.**

ITS SEQUENCE. – PQ279285.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, along trail from Moraine Lake to Consolation Lakes, 51.3315°N, 116.1678°W, 1900 m. alt., on the ground by side of trail in conifer forest, 11.vii.2018, *E. Timdal 18019 & S. Rui* (O L-223663).

***Squamarina lentigera* (Weber) Poelt**

NOTES. – Both specimens contain usnic acid (by TLC).

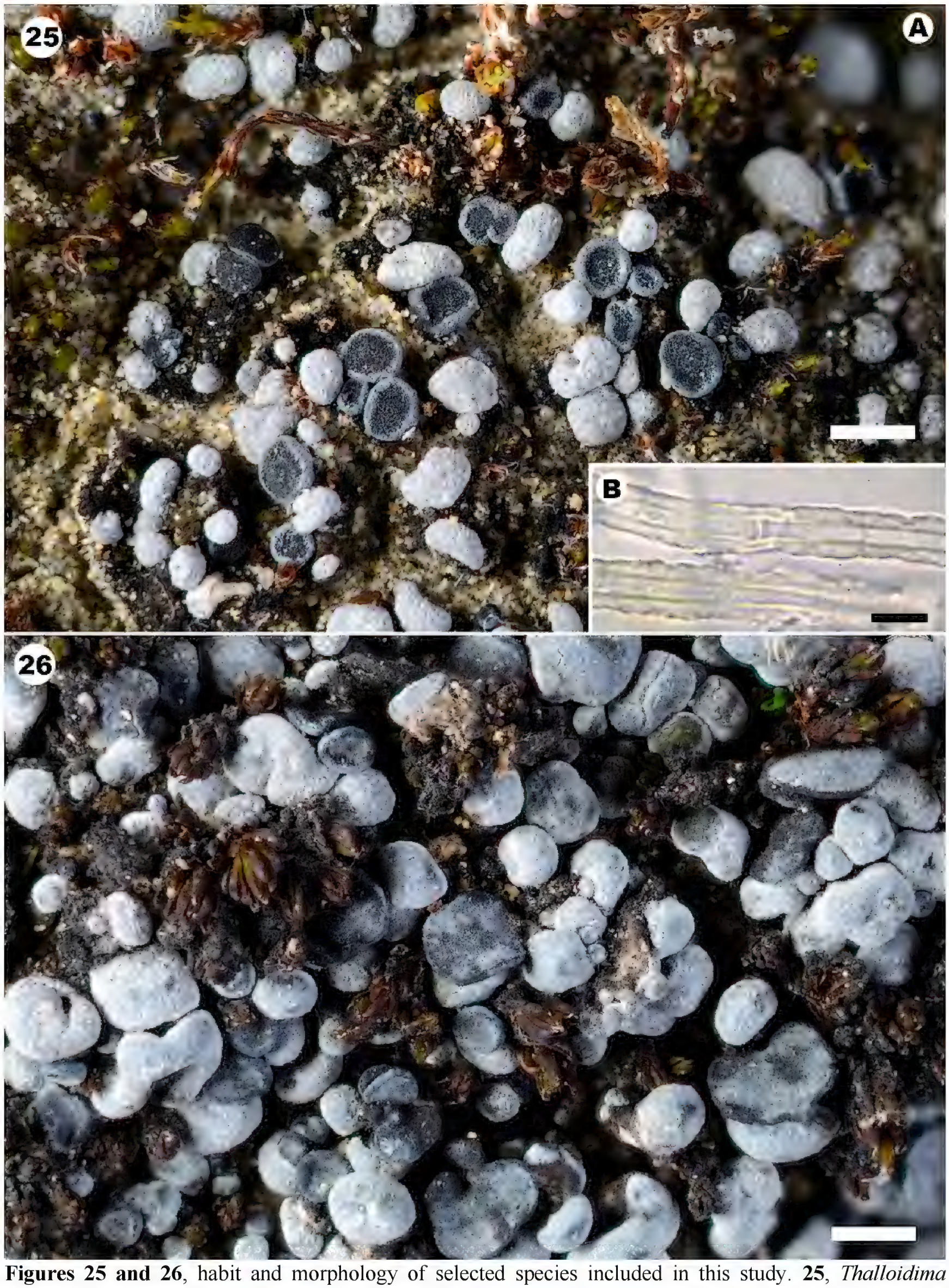
SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0420°N, 116.4177°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18029, S. Rui & T. Spribille* (O L-223673); Jasper National Park, between Edna Lake and Talbot Lake, 53.0828°N, 118.0290°W, 1040 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18048 & S. Rui* (O L-223695).

***Thalloidima alutaceum* Anzi**

ITS SEQUENCE. – PQ279276 (O L-223689).

NOTES. – There is one previous record of the species from Alberta in CLH (2024) (i.e., Banff National Park, near start of Healy Creek Trail, *S.D. Sharnoff & S. Sharnoff 1685.26*, CANL 118650), and one additional record in ABMI (2024, as *Toninia alutacea*). Our ITS sequence was recovered within the *T. alutaceum* clade in the *Thalloidima* phylogeny (Fig. 8).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, N end of Maligne Lake, 52.7233°N, 117.6297°W, 1685 m. alt., on vertical face of rock at forest edge, 13.vii.2018, *E. Timdal 18041 & S. Rui* (O L-223686); Jasper National Park, Maligne Canyon, 52.9197°N, 118.005°W, 1140 m. alt., on vertical rock wall in conifer forest, near stream, 13.vii.2018, *E. Timdal 18045 & S. Rui* (O L-223689); Jasper National Park, Tangle Creek, 52.2675°N, 117.2865°W, 1870 m. alt., on steep to vertical, exposed rock wall, 15.vii.2018, *E. Timdal 18059 & S. Rui* (O L-223706).




**Figures 25 and 26**, habit and morphology of selected species included in this study. **25**, *Thalloidima physaroides*, from Jasper National Park (*Timdal 18049 & Rui*) with micromorphology illustrated in **A** and anatomy of medullary hyphae mounted in water and viewed under normal light illustrated in **B**. **26**, *Thalloidima squamatum*, from Jasper National Park, *Timdal 18060 & Rui*). Scales = 1 mm in 25A and 26, 10 µm in 25B.

***Thalloidima candidum* (Weber) A. Massal.**

ITS SEQUENCE. – PQ279257.

NOTES. – There are four previous records of this species from Alberta in CLH (2024). The species is morphologically similar to *T. alutaceum*, but differs mainly in having more farinose (not granulose) prunina on the upper surface of the squamules, a more reddish brown inner part of the exciple and hypothecium, and 1-septate, fusiform (not acicular, 3-septate) ascospores (Timdal 1992; as *Toninia candida*). Our ITS sequence was recovered within the *T. candidum* clade in the *Thalloidima* phylogeny (Fig. 8).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0413°N, 116.4268°W, 1380 m. alt., on steep face of boulder in conifer forest, 12.vii.2018, *E. Timdal 18038a, S. Rui & T. Spribille* (O L-223682).

****Thalloidima physaroides* (Opiz) Opiz**

**FIGURE 25.**

ITS SEQUENCE. – PQ279283 (O L-223696).

NOTES. – This species is fairly common on calcareous soil in open habitats in Europe and is also known from a few scattered occurrences in Asia, Mediterranean Africa, and North America (Timdal 1992; as *Toninia physaroides*). In North America, it is known from one locality each in Greenland, British Columbia, and Idaho (Timdal 1992, McCune 2017, CLH 2024). The record from British Columbia (McCune 2017) is apparently not published in detail, but may be based on a specimen previously examined by us (see specimens examined below).

The species resembles *Thalloidima sedifolium* (Scop.) Kistenich et al., but differs in subtle morphological characters (Timdal 1992), especially in the presence of pseudocyphellae. They are often poorly developed, however, and identification often requires close inspection. The thickness of the cell wall of the medullary hyphae is diagnostic: in *T. physaroides*, they are strikingly thick-walled (Fig. 25B), up to 4 µm wide (although many are thinner); in *T. sedifolium*, they are exclusively thin-walled, about 1 µm wide.

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, between Edna Lake and Talbot Lake, 53.0828°N, 118.0288°W, 1040 m. alt., on soil in open habitat, 14.vii.2018, *E. Timdal 18049 & S. Rui* (O L-223696); Jasper National Park, between Edna Lake and Talbot Lake, 53.0823°N, 118.0297°W, 1040 m. alt., on soil in open habitat, among shrubs in flat area, 14.vii.2018, *E. Timdal 18055 & S. Rui* (O L-223702); N of Brulé Lake, picnic site ca. 1.1 km ENE of Solomon, 53.3393°N, 117.8197°W, 1060 m. alt., on soil in steep slope, exposed situation, 17.vii.2018, *E. Timdal 18096 & S. Rui* (O L-223741). BRITISH COLUMBIA: Osoyoos area, 4 km SE of town near U.S. border, open rocky, SW slope with *Artemisia-Agropyron spicatum*, 350 m elev., 1990-05-30, *T. Goward & T. Lea 90-1050* (UBC).

*****Thalloidima sedifolium* (Scop.) Kistenich, Timdal, Bendiksby & S. Ekman**

ITS SEQUENCE. – PQ219490.

NOTES. – The species was recently split into *Thalloidima sedifolium* s. str. and *T. squamatum* by Westberg et al. (2023), based on European material and one specimen of *T. squamatum* from Greenland. We here confirm the occurrence of *T. sedifolium* s. str. in North America (Alberta, California, and Utah) (Fig. 8). Both species appear to be common in Europe, and North American material previously identified as *T. sedifolium*, for instance by Timdal (1992; as *Toninia sedifolia*), is in need of revision.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0422°N, 116.4177°W, 1340 m. alt., on soil in open habitat, 12.vii.2018, *E. Timdal 18027, S. Rui & T. Spribille* (O L-223671).

****Thalloidima squamatum* (Hoffm.) M. Westb. & Timdal**

**FIGURE 26.**

ITS SEQUENCE. – PQ219491 (O L-223683), PQ279256 (O L-223707).

NOTES. – The morphological differences between *Thalloidima squamatum* and *T. sedifolium* s. str. are subtle, but *T. squamatum* can usually be identified by its larger squamules and apothecia, paler inner part of the proper exciple, shorter and broader ascospores, and its tendency to grow in moss cushions or in rock fissures, not directly on soil (Westberg et al. 2023). Phylogenetically, it is the sister species of *T. physaroides*, but can be distinguished from that species by the lack of pseudocyphellae and by having exclusively thin-walled medullary hyphae. Our ITS sequences from Alberta were recovered in the *T. squamatum* clade (Fig. 8).

These are the second and third records from North America, the first one having been reported from Greenland by Westberg et al. (2023). Our phylogenetic reconstruction (Fig. 8) revealed one more record from Canada (GenBank No. HQ650689, Quebec, based on *F. Lutzoni et al. 07.08.03-9*, DUKE), originally identified as *Toninia sedifolia*.

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0413°N, 116.4268°W, 1380 m. alt., on steep face of boulder in conifer forest, 12.vii.2018, *E. Timdal 18038b, S. Rui & T. Spribille* (O L-223683); Jasper National Park, Tangle Creek, 52.2677°N, 117.2868°W, 1870 m. alt., on steep to vertical, exposed rock wall, 15.vii.2018, *E. Timdal 18060 & S. Rui* (O L-223707).

ADDITIONAL SPECIMEN, IDENTIFIED BY ITS SEQUENCE ONLY. – **CANADA.** QUEBEC: Mingan Islands, Île Niapiskau, 50.2032°N, 63.7309°W, on rocky barren near shoreline, on mosses among flat pebbles, 2003-07-08, *F. Lutzoni et al. 07.08.03-9* (DUKE 47744 – AFTOL-ID 213) [label data from CLH (2024)].

***Toninia asiae-centralis* (H. Magn.) Timdal, comb. nov.**

Mycobank #855510

≡ *Lecidea asiae-centralis* H. Magn., Lich. cent. Asia: 55. 1940. ≡ *Toninia tristis* subsp. *asiae-centralis* (H. Magn.) Timdal, Opera Botanica 110: 112. 1991[1992]. ≡ *Psora asiae-centralis* (H. Magn.) N.S. Golubk., Botanicheskii Zhurnal 56: 781. 1971. **TYPE: CHINA:** Gansu, Yü-shu-ku, ca. 25 km NW a Chia-yü-kuan, in latere septentr. mont. Hei-shan, alt. 1550-1600 m, 13.x.1930, *B. Bohlin 26d* (S!, holotype).

ITS SEQUENCES. – PQ279266 (O L-223679), PQ279281 (O L-223708).

NOTES. – For the change of rank for this taxon, refer to the Discussion section above. It is the most widely distributed species in the *T. tristis* complex, occurring in arid areas throughout the temperate zone of the Northern Hemisphere and also in Peru (Timdal 1992, as *T. tristis* subsp. *asiae-centralis*). The terpenoid pattern of this species is unique and was referred to as "chemotype 4" by Timdal (1992). Our three specimens from Alberta fit that chemotype (by TLC; Fig. 10).

SPECIMENS EXAMINED. – **CANADA.** ALBERTA: Kootenay Plains Ecological Reserve, 52.0423°N, 116.4197°W, 1340 m. alt., on thin soil on top of boulder in open conifer forest, 12.vii.2018, *E. Timdal 18035, S. Rui & T. Spribille* (O L-223679); Kootenay Plains Ecological Reserve, 52.0413°N, 116.4268°W, 1380 m. alt., on steep face of boulder in open conifer forest, 12.vii.2018, *E. Timdal 18037, S. Rui & T. Spribille* (O L-223681); Jasper National Park, Tangle Creek, 52.2677°N, 117.2868°W, 1870 m. alt., on steep to vertical, exposed rock wall, 15.vii.2018, *E. Timdal 18061 & S. Rui* (O L-223708).

***Toninia squalida* (Ach.) A. Massal.**

NOTES. – There is one previous record from Alberta in the CLH (2024) database (i.e., Jasper National Park, Jonas Rock Slide, *I.M. Brodo et al. 31305*, CANL 130317).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Athabasca Falls, 52.6648°N, 117.8848°W, 1170 m. alt., on rock outcrop in slope towards the river, 14.vii.2018, *E. Timdal 18047d & S. Rui* (O L-223694).

****Toninia tristis* (Th. Fr.) Th. Fr.**

ITS SEQUENCE. – PQ219492.

NOTES. *Toninia tristis* s. str. was reported from Scandinavia, Central Europe, and the U.S.A. (Arizona, Colorado, Utah) by Timdal (1992, as *T. tristis* subsp. *tristis*). It is listed from Alberta by Environment and Parks (2022), but there are no records from Canada in CLH (2024). We here confirm its occurrence in Canada. The terpenoid pattern of this species is unique and was referred as "chemotype 1" by Timdal (1992). Our specimen from Alberta fits that chemotype (by TLC; Fig. 10).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, S end of Talbot Lake, 53.0863°N, 118.0255°W, 1040 m. alt., in crevices in steep limestone wall, 14.vii.2018, *E. Timdal 18056 & S. Rui* (O L-223703).

***Umbilicaria polaris* (Schol.) Zahlbr.**

ITS SEQUENCE. – PQ279275.

NOTES. – There are several records of this species from Banff National Park in CLH (2024), mainly identified as *U. krascheninnikovii* (Savicz) Zahlbr., but none from Jasper National Park. The sequence of our specimen is only 97.2% similar to the nearest GenBank sequence of *U. polaris* (KY947759) and there are actually two sequences of *U. decussata* (Vill.) Zahlbr. that are more similar (97.4 – 97.8%). Davydov et al. (2017) suggest treating the two species as conspecific.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Jasper National Park, Mount Whistler, 52.8272°N, 118.1355°W, 2410 m. alt., on rock in the alpine region, 16.vii.2018, *E. Timdal 18084 & S. Rui* (O L-223730).

***Vulpicida juniperinus* (L.) J.-E. Mattsson & M.J. Lai**

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Parker Ridge, above Hilda Creek, 52.1875°N, 117.1272°W, 2160 m. alt., on the ground in the alpine region, 15.vii.2018, *E. Timdal 18069b & S. Rui* (O L-223714).

***Xanthomendoza fallax* (Arnold) Søchting, Kärnefelt & S.Y. Kondr.**

ITS SEQUENCE. – PQ279284.

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Three Hills, in the town, 51.7070°N, 113.2593°W, 910 m. alt., on trunk of deciduous tree by road, 09.vii.2018, *E. Timdal 18007 & S. Rui* (O L-223651).

***Xylopsora friesii* (Ach.) Bendiksby & Timdal**

**FIGURE 17B.**

ITS SEQUENCE. – PP415253.

NOTES. – Although much collected in British Columbia (CLH 2024), there is only one previous collection from Alberta in the CLH (2024) database (i.e., between Hinton and Grande Cache on Hwy 40, *B. Goffinet 4090*, CONN barcode 01001147) and one additional record in ABMI (2024). *Xylopsora friesii* is genetically heterogeneous (Bendiksby & Timdal 2013, Bendiksby et al. 2018), and our Canadian specimen matches with 100% similarity (100% query cover) specimen "*X. friesii* 1" in those two published studies. It is morphologically very similar to *Fulgidea oligospora* (Fig. 17) and the two species can hardly be distinguished in the field but require anatomical, chemical, or genetic study (Timdal 2001b). Our specimen contains friesiic acid (by TLC).

SPECIMEN EXAMINED. – **CANADA.** ALBERTA: Banff National Park, Bow Valley Parkway, forest trail from parking lot ca. 1.6 km NW of crossing of Johnston Canyon, 51.2600°N, 115.8577°W, 1470 m. alt., on burnt stump in confer forest, 10.vii.2018, *E. Timdal 18012 & S. Rui* (O L-223656).

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## APPENDIX I: ADDITIONAL NEW COMBINATIONS FOR THE SUBSPECIES OF *TONINIA TRISTIS*

***Toninia arizonica*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855511.

≡ *Toninia tristis* subsp. *arizonica* Timdal, Opera Botanica 110: 112. 1991[1992]. **TYPE: U.S.A.** ARIZONA: COCHISE CO.: Chiricahua Mountains, limestone area below Herb Martyr Reservoir, on limestone, 30.iii.1961, *W.A. Weber & D.D. Awasthi S-28059* (COLO!, holotype).

***Toninia canadensis*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855512.

≡ *Toninia tristis* subsp. *canadensis* Timdal, Opera Botanica 110: 113. 1991[1992]. **TYPE: CANADA.** NORTHWEST TERRITORIES: Inuvik, District of Mackenzie, T-48, Dolomite Lake, 68°17'N, 133°27'W, 6.viii.1965, *G.W. Scotter 6097* (CANL!, holotype; H!, UAC!, isotypes).

***Toninia chihuahuana*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855514.

≡ *Toninia tristis* subsp. *chihuahuana* Timdal *in* Nash et al. (eds), Lichen Flora of the Greater Sonoran Desert Region Volume 1: 499. 2002. **TYPE: MEXICO.** CHIHUAHUA: Barranca del Cobre, small, broad secondary valley within the canyon with pines (*Pinus chihuahuana*, *Pinus* spp.), some oaks (*Quercus crassifolia* and *Quercus* spp.) and cypress (*Cupressus arizonica*), 27.4383°N, 107.4883°W, 1800 m. alt., 21.vii.1994, *E. Timdal SON68/31* (O L-15850!, holotype).

***Toninia coahuilae*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855513.

≡ *Toninia tristis* subsp. *coahuilae* Timdal, Opera Botanica 110: 113. 1991[1992]. **TYPE: MEXICO.** COAHUILA: Cuatro Cienegas basin, S side, Chihuahuan desert, limestone area, limestone cliff, ca. 27°11'N, 102°16'W, alt. 2900 ft, 21.iii.1973, *T.H. Nash 6738* (ASU!, holotype).

***Toninia fujikawae*** (Satô) Timdal, *comb. nov.*
Mycobank #855515.

≡ *Lecidea fujikawae* M. Satô, Journal of Japanese Botany 12: 48, Figs 27-28. 1936. ≡ *Toninia tristis* subsp. *fujikawae* (M. Satô) Timdal, Opera Botanica 110: 113. 1991[1992]. **TYPE: JAPAN.** HONSHU: prope Todai, Prov. Sinano,15.x.1935, *F. Fujikawa s.n.* (TNS!, holotype; BM!, H!, isotypes).

***Toninia gigantea*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855516.

≡ *Toninia tristis* subsp. *gigantea* Timdal *in* Nash et al. (eds), Lichen Flora of the Greater Sonoran Desert Region Volume 1: 499. 2002. **TYPE: MEXICO.** BAJA CALIFORNIA SUR. Sierra de La Giganta at 70 km post, 25.55°N, 111.33°W, 410-470 m. alt., 19.ii.1993, *E. Timdal SON25/04* (O L-15465!, holotype).

***Toninia pseudotabacina*** (Timdal) Timdal, *comb. et stat. nov.*
Mycobank #855517.

≡ *Toninia tristis* subsp. *pseudotabacina* Timdal, Opera Botanica 110: 113. 1991[1992]. **TYPE: ITALY.** VENETO: Verona, ad terram in oppido Fumane (M. Incisa) prov. Veronensis haud rare, *A.B. Massalongo & C. Tonini s.n.* = *Massalongo Lich. It. Exs. 52* (UPS!, holotype; BM!, M!, NEB!, O!, S!, isotypes).

***Toninia scholanderi*** (Lynge) Timdal, *comb. nov.*
Mycobank #855518.

≡ *Lecidea scholanderi* Lynge, Skrifter om Svalbard og Ishavet 81: 47. 1940. ≡ *Toninia tristis* subsp. *scholanderi* (Lynge) Timdal, Opera Botanica 110: 115. 1991[1992]. ≡ *Psora scholanderi* (Lynge) R.A. Anderson, [schedae to] Lichens of western North America, Fasc. 1 (No. 1-25): 6. 1976. **TYPE: GREENLAND:** Geographical Society Øya, vest for Scott Keltie Øya, Husbukta, 8.viii.1929, *B. Lynge s.n.* (O L-117!, holotype).

***Toninia thalloedaemiformis*** (Szatala) Timdal, *comb. nov.*
Mycobank #855519.

≡ *Lecidea thalloedaemiformis* Szatala, Borbasia 3: I25. 1941. ≡ *Toninia tristis* subsp. *thalloedaemiformis* (Szatala) Timdal, Opera Botanica 110: 115. 1991[1992]. **TYPE: GREECE.** MACEDONIA: peninsula Hagion Oros, ad monostir Aja Anna, in fissuris rupium calcariis, alt. ca. 300 m, 24.viii.1934, *Ö. Szatala s.n.* (BP!, holotype).

## APPENDIX II: MOLECULAR VOUCHER METADATA

**Table 1.** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Caloplaca | *Caloplaca albolutescens* | *J. Vondrák 8849* (PRA) | Italy | - | - | MN305824 |
| Caloplaca | *Caloplaca albopruinosa* | *M. Tretiach & L. Muggia s.n.* (TSB 37658) | Italy | - | - | MH100770 |
| Caloplaca | *Caloplaca albosquamata* | *E. Timdal & S. Rui 18053* (O L-223700) | Canada | **PQ279291** | - | **PQ226160** |
| Caloplaca | *Caloplaca alstrupii* | *J. Vondrák 19342* (PRA) | United Kingdom | OQ717771 | - | - |
| Caloplaca | *Caloplaca aractina* | *J. Vondrák 6702* (PRA) | Czech Republic | - | - | MH100773 |
| Caloplaca | *Caloplaca areolata* | *J. Vondrák 10843* (PRA) | Italy | - | - | MN305825 |
| Caloplaca | *Caloplaca atroalba* | *T. Spribille s.n.* (herbarium unknown) | USA | - | - | MH100774 |
| Caloplaca | *Caloplaca aureopruinosa* | *I. Frolov 2473* (hb. Frolov ?) | Russia | - | - | MW227331 |
| Caloplaca | *Caloplaca aureopruinosa* | *S. Chesnokov 154* (LE-L15207) | Russia | - | - | MW227332 |
| Caloplaca | *Caloplaca aureopruinosa* | *L. Konoreva 68* (LE-L15209) | Russia | - | - | MW227333 |
| Caloplaca | *Caloplaca badioreagens* | *sine coll.* (TSB 36422) | Italy | - | - | MH100776 |
| Caloplaca | *Caloplaca bicolor* | *J. Vondrák 10373* (PRA) | Russia | - | - | MH100777 |
| Caloplaca | *Caloplaca borealis* | *I. Frolov 1176* (hb. Frolov ?) | Russia | KX216688 | - | - |
| Caloplaca | *Caloplaca borealis* | *I. Frolov 2476* (hb. Frolov ?) | Russia | - | - | MW227334 |
| Caloplaca | *Caloplaca cancarixiticola* | *X. Llimona & J.M. Egea s.n.* (MUB) | Spain | - | - | KT291482 |
| Caloplaca | *Caloplaca catalinae* | *E. Gaya 02.26.10-13 & F. Lutzoni* (DUKE) | USA | - | - | KT291477 |
| Caloplaca | *Caloplaca ceracea* | *P.W. James s.n.* (BM-6656) | United Kingdom | HQ234603 | - | - |
| Caloplaca | *Caloplaca cerina* | *U. Arup s.n.* (LD-L03347) | Sweden | EU365861 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Caloplaca | *Caloplaca cerina* | *E. Gaya et al. s.n.* (DUKE) | USA | - | - | JQ301483 |
| Caloplaca | *Caloplaca chilensis* | *D. Stanton 0212-0508* (SGO) | Chile | - | - | JQ301485 |
| Caloplaca | *Caloplaca chlorina* | *J. Vondrák 3034* (CBFS) | Czech Republic | HM538515 | - | - |
| Caloplaca | *Caloplaca cinnamomea* | *F. Lutzoni & C. Gueidan 06.08.07-1* (DUKE) | Iceland | - | - | JQ301487 |
| Caloplaca | *Caloplaca circumalbata* | *M. Halici s.n.* (herbarium unknown) | Turkey | - | - | MH100780 |
| Caloplaca | *Caloplaca concreticola* | *J. Vondrák & J. Soun s.n.* (CBFS ?) | Romania | EU192154 | - | - |
| Caloplaca | *Caloplaca concreticola* | *J. Vondrak 9443* (PRA) | Kazakhstan | - | - | MH100781 |
| Caloplaca | *Caloplaca conversa* | *E. Gaya 03.03.10-2C & F. Lutzoni* (DUKE) | Mexico | KT291450 | - | KT291504 |
| Caloplaca | *Caloplaca conversa* | *J. Vondrak 5538* (PRA) | Iran | - | - | MH100782 |
| Caloplaca | *Caloplaca crenularia* | *E. Gaya et al. s.n.* (BCN) | Sweden | - | - | JQ301489 |
| Caloplaca | *Caloplaca cretensis* | *I. Frolov s.n.* (hb. Frolov ?) | Portugal | - | - | MH100783 |
| Caloplaca | *Caloplaca diphyodes* | *I. Frolov 1430* (hb. Frolov ?) | France | - | - | MH100785 |
| Caloplaca | *Caloplaca emilii* | *J. Vondrak 9358* (PRA) | Czechia | - | - | MH100787 |
| Caloplaca | *Caloplaca erythrocarpa* | *sine coll. 98GB03* (herbarium uknown) | ??? Unknown | MN985042 | - | - |
| Caloplaca | *Caloplaca erythrocarpa* | *J. Vondrak 6650* (PRA) | Russia | - | - | MN305826 |
| Caloplaca | *Caloplaca exsecuta* | *T. Tønsberg 46194* (BG) | Norway | MG954211 | - | - |
| Caloplaca | *Caloplaca flavorubescens* | ??? Unknown | ??? Unknown | - | - | AY143403 |
| Caloplaca | *Caloplaca fluviatilis* | *J. Vondrak 11104* (PRA) | Russia | MG954127 | - | - |
| Caloplaca | *Caloplaca furax* | *S. Fernandez Brime et al. 557* (BCN) | Spain | JQ301662 | - | - |
| Caloplaca | *Caloplaca furax* | *J. Vondrak 8714* (PRA) | Greece | - | - | MN305827 |
| Caloplaca | *Caloplaca fuscoatroides* | *J. Vondrak 10805* (PRA) | Italy | - | - | MN305828 |
| Caloplaca | *Caloplaca haematites* | *J. Vondrak 7278* (PRA) | Ukraine | - | - | MH100789 |
| Caloplaca | *Caloplaca hanneshertelii* | *S.Y. Kondratyuk 20415* (LD) | Australia | HM538483 | - | - |
| Caloplaca | *Caloplaca helygeoides* | *I. Frolov 1414* (hb. Frolov ?) | Switzerland | - | - | MH100790 |
| Caloplaca | *Caloplaca inconnexa* ssp. *nesodes* | *E. Gaya 02.27.10-7 & F. Lutzoni* (DUKE) | USA | - | - | KT291495 |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Caloplaca | *Caloplaca isidiigera* | *U. Arup s.n.* (LD-L02352) | Sweden | HM538537 | - | - |
| Caloplaca | *Caloplaca isidiigera* | *J. Soun s.n.* (CBFS) | Slovakia | - | - | JQ301492 |
| Caloplaca | *Caloplaca micromarina* | *J. Vondrak 8199* (CBFS) | Turkey | NR156257 | - | - |
| Caloplaca | *Caloplaca micromarina* | *J. Vondrak 7236* (PRA) | Ukraine | - | - | MH100791 |
| Caloplaca | *Caloplaca micromontana* | *J. Vondrak 9467* (PRA) | Russia | - | - | MH100792 |
| Caloplaca | *Caloplaca molariformis* | *O. Nadyeina 132* (KW) | Ukraine | - | - | MH100793 |
| Caloplaca | *Caloplaca monacensis* | *J. Vondrak 6393 & A. Khodosovtsev* (CBFS) | Hungary | HM538505 | - | - |
| Caloplaca | *Caloplaca neotaurica* | *J. Vondrak 7213* (PRA) | Ukraine | - | - | MN305829 |
| Caloplaca | *Caloplaca obscurella* | *J. Vondrak 27449* (PRA) | Greece | OR490799 | - | - |
| Caloplaca | *Caloplaca pellodella* | *E. Gaya 03.03.10-2A & F. Lutzoni* (DUKE) | Mexico | - | - | KT291505 |
| Caloplaca | *Caloplaca percrocata* | *J. Vondrak 4634* (PRA) | Italy | - | - | MH100794 |
| Caloplaca | *Caloplaca pratensis* | [*C.M. Wetmore 95180* ???] (MIN-891605) | USA | - | - | MH100795 |
| Caloplaca | *Caloplaca reptans* | *J.C. Lendemer 11745* (NY) | USA | - | - | JQ686191 |
| Caloplaca | *Caloplaca sideritis* | *M.K. Adavita 5073* (LD) | USA | MT967382 | - | - |
| Caloplaca | *Caloplaca soralifera* | *J. Vondrak 10813* (PRA) | France | - | - | MN305830 |
| Caloplaca | *Caloplaca stillicidiorum* | *U. Søchting 7440* (C) | USA | HM538568 | - | - |
| Caloplaca | *Caloplaca subalpina* | J. Vondrak 692 (CBFS) | Spain | EU365854 | - | - |
| Caloplaca | *Caloplaca teicholyta* | *J. Vondrak 6943* (PRA) | Ukraine | - | - | MH100797 |
| Caloplaca | *Caloplaca thracopontica* | *J. Soun s.n.* (CBFS) | Turkey | JQ301668 | - | - |
| Caloplaca | *Caloplaca tianshanensis* | *A. Abbas & H. Xahidin 20090001* (XJU-1691) | China | - | - | MH100798 |
| Caloplaca | *Caloplaca transcaspica* | *sine coll. 14-10-1106* (herbarium unknown) | China | MN103119 | - | - |
| Caloplaca | *Caloplaca transcaspica* | *J. Vondrak 9430* (PRA) | Kazakhstan | - | - | MH100799 |
| Caloplaca | *Caloplaca turkuensis* | *U. Arup s.n.* (LD-L04229) | Sweden | HM538490 | - | - |
| Caloplaca | *Caloplaca ulmorum* | *M.K. Advaita 6490* (GZU) | USA | HM538509 | - | - |
| Caloplaca | *Caloplaca variabilis* | *J. Vondrak 5114* (PRA) | Czech Republic | - | - | MH100800 |
| Caloplaca | *Caloplaca xerica* | *J. Vondrak 14544* (PRA) | Russia | - | - | MN305831 |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Caloplaca | *Caloplaca* sp. | *E. Gaya 19.2.11- 37 & I. Vargas* (DUKE) | Chile | - | - | KT291508 |
| Caloplaca | *Caloplaca* sp. | *J. Vondrak 9673* (PRA) | Czech Republic | - | - | MH100778 |
| Caloplaca | *Caloplaca* sp. | *I. Frolov 1456* (hb. Frolov ?) | Abkhazia | - | - | MH100786 |
| Caloplaca | *Fulgensia canariensis* | *P.L. Perez de Paz & C. Hernandez-Padron s.n.* (TFC Lich 3593) | Spain | - | - | KT291516 |
| Caloplaca | *Gyalolechia bracteata* | *P. Alanko 121555* (H) | Estonia | - | - | JQ301502 |
| Caloplaca | *Gyalolechia stipitata* | *E. Gaya 03.06.10-5 & F. Lutzoni* (DUKE) | Mexico | - | - | KT291490 |
| Caloplaca | *Kuettlingeria atroflava* | *E. Gaya 02.27.10-8a & F. Lutzoni* (DUKE) | USA | - | - | KT291511 |
| Caloplaca | *Kuettlingeria atroflava* | *J. Vondrak 8723* (PRA) | Greece | - | - | MH100775 |
| Caloplaca | *Lendemeriella reptans* | *J.C. Lendemer 48186* (NY) | USA | - | - | MH100796 |
| Caloplaca | *Leproplaca proteus* | *E. Gaya 215 & X. Llimona* (BCN 13706) | Spain | - | - | KT291507 |
| Caloplaca | *Leproplaca xantholyta* | *T. Spribille 12970* (B) | Greece | - | - | JQ301501 |
| Caloplaca | *Olegblumia demissa* | *J. Vondrak 13127* (PRA) | Spain | - | - | MH100784 |
| Caloplaca | *Polycauliona candelaria* | *E. Gaya et al. s.n.* (BCN) | Sweden | - | - | JQ301528 |
| Caloplaca | *Pyrenodesmia albopustulata* | *J. Vondrak 10463* (PRA) | Turkey | - | - | MH100771 |
| Caloplaca | *Pyrenodesmia alociza* | *J. Vondrack 776* (TSB-37735) | Italy | - | - | MH100772 |
| Caloplaca | *Pyrenodesmia chalybaea* | *I. Gavalas IRGA 345* (B 60 0203823) | Greece | MN512249 | - | - |
| Caloplaca | *Pyrenodesmia chalybaea* | E. Gaya et al. s.n. (BCN) | Sweden | - | - | JQ301484 |
| Caloplaca | *Pyrenodesmia chalybaea* | *J. Vondrak 4059* (PRA) | Greece | - | - | MH100779 |
| Caloplaca | *Pyrenodesmia erodens* | *J. Vondrak 12733* (PRA) | Turkey | - | - | MH100788 |
| Caloplaca | *Pyrenodesmia microstepposa* | *M. Usmnan GC64* (LAH) | Pakistan | OQ789201 | - | - |
| Caloplaca | *Rufoplaca scotoplaca* | *E. Gaya et al. s.n.* (BCN) | Sweden | - | - | JQ301497 |
| Caloplaca | *Seirophora californica* | *E. Gaya 03.04.10-9 & F. Lutzoni* (DUKE) | Mexico | - | - | KT291521 |
| Caloplaca | *Seirophora contortuplicata* | *U. Søchting s.n.* (herbarium unknown) | Tajikistan | - | - | KT291522 |
| Caloplaca | *Seirophora lacunosa* | *A. Pérez s.n.* (BCN) | Spain | - | - | JQ301517 |
| Caloplaca | soil sample | [isolate] S611 | India | SH1097576-09FU | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Caloplaca | *Teloschistes nodulifer* | *E. Gaya 07.05.10-7 & D. Ramos* (DUKE) | Peru | - | - | KT291524 |
| Caloplaca | *Usnochroma carphinea* | *S. Fernandez-Brime et al. 542* (BCN) | Spain | - | - | JQ301482 |
| Caloplaca | *Usnochroma scoriophila* | *P.P.G. v.d. Boom 38386* (hb. v.d. Boom) | Spain | - | - | JQ301496 |
| Caloplaca | *Variospora aurantia* | *P. Navarro-Rosinés & X. Llimona s.n.* (BCN 13326) | Spain | - | - | KT291479 |
| Caloplaca | *Variospora paulii* | *E. Gaya 183* (BCN) | Spain | - | - | KT291503 |
| Caloplaca | *Variospora thallincola* | *E. Gaya et al. s.n.* (BCN) | Sweden | - | - | JQ301498 |
| Caloplaca | *Variospora velana* | *U. Arup s.n.* (LD-L07123) | Italy | - | - | KT291515 |
| Caloplaca | *Xanthomendoza borealis* | *P. Crittenden s.n.* (DUKE) | Antarctica | - | - | KT291526 |
| Caloplaca | *Xanthomendoza mendozae* | *V. Reeb 11-V-02-14* (DUKE) | Bolivia | - | - | JQ301523 |
| Caloplaca | *Yoshimuria cerussata* | *U. Søchting 7628* (C) | Antarctica | - | - | KT291519 |
| Elixia | *Boreoplaca ultrafrigida* | *T. Spribille 31796* (GZU) | Russia | MN483108 | MN460212 | MN508266 |
| Elixia | *Elixia cretica* | *H. Streimann & J.A. Curnow 50968* (CANB 9304299) | Australia | KF360371 | KF360448 | - |
| Elixia | *Elixia cretica* | *E. Timdal SON78/03* (O L-15969) | Mexico | KF360372 | KF360449 | KF360419 |
| Elixia | *Elixia cretica* | *T. Spribille 13340* (GZU) | Greece | - | - | GQ892058 |
| Elixia | *Elixia flexella* | *J. Halda et al. 12407* (O L-157191) | Austria | KF360373 | KF360450 | KF360420 |
| Elixia | *Elixia flexella* | *J. Vondrak 23517* (PRA) | Czechia | OQ717833 | - | OQ646214 |
| Elixia | *Elixia flexella* | *Z. Palice s.n.* (ESS 21517) | ??? Unknown | - | AY300837 | AY300887 |
| Elixia | *Elixia flexella* | *Z. Palice s.n.* (hb. Palice) | Turkey | - | AY853368 | AY853320 |
| Elixia | *Elixia praeruptorum* | *E. Timdal & S. Rui 18043* (O L-223687) | Canada | **PQ279269** | - | **PQ226159** |
| Elixia | *Elixia* sp. | *T.H. Nash 11177* (ASU) | USA | KF360374 | KF360451 | - |
| Elixia | *Elixia* sp. | *T.H. Nash 41750* (ASU) | USA | KF360375 | KF360452 | - |
| Elixia | *Fulgidea oligospora* | *T.H. Nash 42735a* (O L-767) | USA | KF360395 | KF360465 | - |
| Elixia | *Fulgidea oligospora* | *S. Rui & E. Timdal US215/01* (O L-59862) | USA | KF360396 | KF360466 | KF360434 |
| Elixia | *Fulgidea oligospora* | *S. Rui & E. Timdal US272/01* (O L-59992) | USA | KF360397 | KF360467 | KF360435 |
| Elixia | *Fulgidea oligospora* | *R. Haugan & E. Timdal YAK04/05* (O L-18713) | Russia | KF360398 | KF360468 | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Elixia | *Fulgidea sierrae* | *S. Rui & E. Timdal US249/01* (O L-59964) | USA | KF360402 | KF360471 | KF360437 |
| Elixia | *Fulgidea sierrae* | *E. Timdal SON125/01* (O L-60059) | USA | KF360403 | - | - |
| Elixia | *Meridianelia maccarthyana* | *G. Kantvilas 752/03* (F) | Australia | - | - | FJ763185 |
| Elixia | *Miriquidica* sp. | *D.F. Stone 8170* (OSC-164195) | USA | KF024743 | KF024745 | - |
| Elixia | *Ophioparma araucariae* | *L. Wang et al. 14-46869* (KUN-L 14-46869) | China | KY131776 | - | - |
| Elixia | *Ophioparma handelii* | *L. Wang et al. 14-46756* (KUN-L 14-46756) | China | KY131765 | - | - |
| Elixia | *Ophioparma lapponica* | *T. Wheeler WG2-0006* (O L-195838) | Norway | KY266901 | - | - |
| Elixia | *Ophioparma lapponica* | [isolate] AFTOL ID 1707 | ??? Unknown | - | DQ973028 | - |
| Elixia | *Ophioparma lapponica* | *E. Timdal 12353* (O L-170853) | Norway | - | - | KF360443 |
| Elixia | *Ophioparma pruinosa* | *L. Wang et al. 15-49762* (KUN-L 15-49762) | China | KY131767 | - | - |
| Elixia | *Ophioparma ventosa* | *R. Haugan 7615* (O L-151477) | Norway | KF360415 | KF360474 | KF360444 |
| Elixia | *Umbilicaria hyperborea* | *B. McCune 30048* (OSC) | USA | MH302517 | MH290351 | - |
| Elixia | *Umbilicaria hyperborea* | *K. Wiklund 25* (UPS) | Norway | - | - | AY853349 |
| Elixia | *Umbilicaria rigida* | *B. McCune 35009* (OSC) | USA | MH302527 | MH290347 | - |
| Elixia | *Umbilicaria rigida* | [isolate] AFTOL ID 1267 | ??? Unknown | - | - | DQ986873 |
| Elixia | *Umbilicaria vellea* | *G. Hestmark 5038B* (O L-228500) | Bolivia | HM161490 | HM161544 | HM161585 |
| Elixia | *Xylopsora canopeorum* | *R. Reese Naesborg 1522* (JEPS) | USA | MG309307 | - | MG309311 |
| Elixia | *Xylopsora caradocensis* | *E. Timdal 2410* (O L-32967) | Norway | KF360383 | - | - |
| Elixia | *Xylopsora caradocensis* | *G. Odelvik 599* (S L-29227) | Sweden | - | - | KF360425 |
| Elixia | *Xylopsora friesii* | *E. Timdal 11029* (O L-158541) | Norway | KF360388 | KF360459 | KF360428 |
| Gypsoplaca | *Gypsoplaca alpina* | *L. Wang et al. 14-45992* (KUN-L-47940) | China | KY397902 | - | - |
| Gypsoplaca | *Gypsoplaca alpina* | [isolate] G28 (KUN-L-52582) | China | KY397903 | - | - |
| Gypsoplaca | *Gypsoplaca blastidiata* | [isolate] P105 (KUN-L-55279) | China | KY397891 | - | - |
| Gypsoplaca | *Gypsoplaca blastidiata* | [isolate] P72 (KUN-L-55246) | China | KY397895 | - | - |
| Gypsoplaca | *Gypsoplaca bullata* | [isolate] G19 (KUN-L-48278) | China | KY397900 | - | - |
| Gypsoplaca | *Gypsoplaca bullata* | *L. Wang et al. 16-54559* (KUN–L–57979) | China | KY397901 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Gypsoplaca | *Gypsoplaca macrophylla* | *R. Rosentreter 15995* (F) | USA | KF650781 | - | - |
| Gypsoplaca | *Gypsoplaca macrophylla* | [isolate] G16 (KUN–L–24006) | China | KY397884 | - | - |
| Gypsoplaca | *Gypsoplaca macrophylla* | [isolate] P97 (KUN-L-57144) | China | KY397890 | - | - |
| Gypsoplaca | *Gypsoplaca macrophylla* | *Rosentreter & McCune 17157* (O L-184673) | Canada | KY646069 | - | - |
| Gypsoplaca | *Gypsoplaca rosulata* | *L. Wang et al. 16-51831* (KU-–L-55251) | China | MF403100 | - | - |
| Gypsoplaca | *Gypsoplaca rosulata* | *J. Salix 011* (O L-205480) | USA | MF403101 | - | - |
| Gypsoplaca | *Gypsoplaca rosulata* | *E. Timdal s.n.* (O L-205493) | USA | MF403102 | - | - |
| Gypsoplaca | *Gypsoplaca rosulata* | *E. Timdal & S. Rui 18033* (O L-223677 | Canada | **PQ279253** | - | - |
| Gypsoplaca | *Gypsoplaca rosulata* | *E. Timdal & S. Rui 18095* (O L-223740) | Canada | **PQ279255** | - | - |
| Gypsoplaca | *Protoparmelia isidiata* | *M.E.S. Caceres & A. Aptroot 21648* (ISE) | Brazil | KY066262 | - | - |
| Thalloidima | *Bibbya albomarginata* | *E. Timdal 10481* (O L-144851) | Peru | MG926024 | - | - |
| Thalloidima | *Bibbya bullata* | *J.A. Elix & H. Streimann 40393* (O L-68980) | Australia | MG926026 | - | - |
| Thalloidima | *Bibbya ruginosa* | *E. Timdal 10087* (O L-139109) | Greenland | MG926033 | - | - |
| Thalloidima | *Toninia alutacea* | *R. Haugan & E. Timdal 4824* (O L-20272) | Norway | AF282116 | - | - |
| Thalloidima | *Toninia albilabra* | *E. Timdal 13746* (O L-200945) | Spain | MG838187 | - | - |
| Thalloidima | *Toninia albilabra* | *E. Timdal 10480* (O L-144850) | Peru | MG838191 | - | - |
| Thalloidima | *Toninia albilabra* | *R. Haugan 143117* (O L-198896) | Spain | MG926131 | - | - |
| Thalloidima | *Thalloidima albilabrum* | *E. Timdal 16094a* (O L-204884) | Switzerland | **PQ279295** | - | - |
| Thalloidima | *Toninia albilabra* | *M. Westberg SCIN053* (S F298732) | Spain | OR230630 | - | - |
| Thalloidima | *Toninia albilabra* | *M. Westberg SCIN069* (S F298730) | Spain | OR230631 | - | - |
| Thalloidima | *Toninia albilabra* | *J.M.R. Mullor s.n.* (UPS L-790424) | Spain | OR230632 | - | - |
| Thalloidima | *Thalloidima alutaceum* | *J.T. Klepsland JK11-L597* (O L-183755 | Norway | MG838156 | - | - |
| Thalloidima | *Thalloidima alutaceum* | *J.T. Klepsland JK14-L488* (O L-200591) | Norway | MG838164 | - | - |
| Thalloidima | *Thalloidima alutaceum* | *M. Bendiksby et al. 12937* (O L-184350) | Norway | MG838166 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Thalloidima | *Thalloidima alutaceum* | *E. Timdal WG2-0177* (O L-195931) | Norway | MG838194 | - | - |
| Thalloidima | *Thalloidima alutaceum* | *J.T. Klepsland JK11-L442* (O L-177188) | Norway | MG838197 | - | - |
| Thalloidima | *Thalloidima alutaceum* | *S. Rui & E. Timdal 16074* (O L-204671) | Slovakia | **PQ279288** | - | - |
| Thalloidima | *Thalloidima alutaceum* | *E. Timdal & S. Rui 18045* (O L-223689) | Canada | **PQ279276** | - | - |
| Thalloidima | *Thalloidima alutaceum* | *M. Westberg s.n.* (S F298920) | Norway | OR230633 | - | - |
| Thalloidima | *Toninia candida* | *H. Bratli & E. Timdal 8733* (O L-25779) | Norway | AF282117 | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal WG1-0140* (O L-196069) | Norway | MG838163 | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal 13036* (O L-184449 | Spain | MG838170 | - | - |
| Thalloidima | *Thalloidima candidum* | *K.A. Lye & T. Høitomt 34022* (O L-177883) | Norway | MG838185 | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal 13760* (O L-200958) | Spain | MG838202 | - | - |
| Thalloidima | *Thalloidima candidum* | *T.H. Hofton 12366* (O L-194563) | Norway | MG926028 | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal 16101* (O L-204892) | Switzerland | **PQ279262** | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal & S. Rui 18038a* (O L-223682) | Canada | **PQ279257** | - | - |
| Thalloidima | *Thalloidima candidum* | *E. Timdal et al. 19604* (O L-238911) | USA | **PQ279258** | - | - |
| Thalloidima | *Thalloidima diffractum* | *E. Timdal 13035* (O L-184448) | Spain | MG838177 | - | - |
| Thalloidima | *Thalloidima diffractum* | *S. Rui & E. Timdal 16039* (O L-204638) | Slovakia | **PQ279296** | - | - |
| Thalloidima | *Thalloidima diffractum* | *E. Timdal 16100* (O L-204891) | Switzerland | **PQ279278** | - | - |
| Thalloidima | *Thalloidima diffractum* | *M. Westberg HOCH051* (S F262276) | Austria | OR230634 | - | - |
| Thalloidima | *Thalloidima massatum* | *R. Haugan 143132* (O L-198903) | Spain | MG926133 | - | - |
| Thalloidima | *Toninia opuntioides* | *R. Haugan & E. Timdal 8057* (O L-15207) | Norway | AF282119 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *J.T. Klepsland JK11-L599a* (O L-183757) | Norway | MG838158 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *J.T. Klepsland JK11-L621* (O L-183630) | Norway | MG838168 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *M. Bendiksby et al. 12974* (O L-184387) | Norway | MG838172 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *E. Timdal 13443-1* (O L-195603) | Norway | MG838192 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Thalloidima | *Thalloidima opuntioides* | *E. Timdal 16305* (O L-201494) | Norway | **PQ279271** | - | - |
| Thalloidima | *Thalloidima opuntioides* | *E. Timdal 18401* (O L-226098) | Norway | **PQ279274** | - | - |
| Thalloidima | *Thalloidima opuntioides* | *M. Westberg HOCH094* (S F261456) | Austria | OR230635 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *M. Westberg s.n.* (S F298919) | Norway | OR230636 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *M. Westberg & L. Hedenäs 15-242* (S F278000) | Sweden | OR230637 | - | - |
| Thalloidima | *Thalloidima opuntioides* | *B. Coppins & R. Yahr 25032* (UPS L-794042) | United Kingdom | OR230638 | - | - |
| Thalloidima | *Thalloidima physaroides* | *M. Bendiksby et al. 12969* (O L-184382) | Norway | MG926031 | - | - |
| Thalloidima | *Thalloidima physaroides* | *R. Haugan & E. Timdal 8121* (O L-15217) | Norway | MG926032 | - | - |
| Thalloidima | *Thalloidima physaroides* | *S. Rui & E. Timdal 16079* (O L-204676) | Slovakia | **PQ279290** | - | - |
| Thalloidima | *Thalloidima physaroides* | *E. Timdal 16093* (O L-204883) | Switzerland | **PQ279298** | - | - |
| Thalloidima | *Thalloidima physaroides* | *E. Timdal & S. Rui 18049* (O L-223696) | Canada | **PQ279283** | - | - |
| Thalloidima | *Thalloidima physaroides* | *S. Evankow et al. 18899* (O L-228837) | Norway | **PQ279297** | - | - |
| Thalloidima | *Thalloidima physaroides* | *M. Westberg GYN013* (S F256993) | Sweden | OR230639 | - | - |
| Thalloidima | *Thalloidima physaroides* | *M. Westberg GOS065* (S F262703) | Germany | OR230640 | - | - |
| Thalloidima | *Thalloidima physaroides* | *M. Westberg & M. Prieto s.n.* (S F283171) | Sweden | OR230641 | - | - |
| Thalloidima | *Thalloidima physaroides* | *M. Prieto & M. Schultz s.n.* (S F285802) | Sweden | OR230642 | - | - |
| Thalloidima | *Toninia rosulata* | *E. Timdal 8640* (O L-25165) | Norway | AF282121 | - | - |
| Thalloidima | *Thalloidima rosulatum* | *J.T. Klepsland JK11-L209* (O L-177141) | Norway | MG838195 | | |
| Thalloidima | *Thalloidima rosulatum* | *M. Westberg & D. Fontaneto s.n.* (S F298953) | Italy | OR230643 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal & S. Rui 18027* (O L-223671) | Canada | **PQ219490** | - | - |
| Thalloidima | *Toninia sedifolia* | *F. Lutzoni et al. 07.08.03-9* (DUKE 47744) | Canada | HQ650689 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *D. Ertz 7601* (DUKE-0047686) | Belgium | KT232214 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Bendiksby et al. 12919* (O L-184332) | Norway | MG838162 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal 13442-2* (O L-195599) | Norway | MG838193 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Bendiksby et al. 12968* (O L-184381) | Norway | MG838196 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal 13757* (O L-200955) | Spain | MG838199 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *J.T. Klepsland JK10-L156* (O L-183585) | Norway | MG838201 | - | - |
| Thalloidima | *Thalloidima sedifolium* | [isolate] 16-0283 | China | MN103174 | - | - |
| Thalloidima | *Thalloidima sedifolium* | [isolate] 16-0007 | China | MN103175 | - | - |
| Thalloidima | *Thalloidima sedifolium* | [isolate] 16-0270 | China | MN103176 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *P.F. Cannon s.n.* (K(M)-253455) | United Kingdom | MZ159738 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Leavitt 19051* (BYR-C) | USA | MZ922223 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Leavitt 19057* (BYR-C) | USA | MZ922224 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Leavitt 19069* (BYR-C) | USA | MZ922225 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Leavitt 19043* (BYR-C) | USA | MZ922226 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Leavitt 19134* (BYR-C) | USA | MZ922227 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *S. Rui & E. Timdal 18566* (O L-228578) | Spain | **PQ279270** | - | - |
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal et al. 19591* (O L-238898) | USA | **PQ279273** | - | - |
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal et al. 19600* (O L-238907) | USA | **PQ279289** | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg GYN028* (S F257006) | Sweden | OR230644 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg SCIN055* (S F298916) | Spain | OR230645 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg GOS047* (S F262698) | Germany | OR230646 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg SCIN056* (S F298912) | Spain | OR230647 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg s.n.* (S F298921) | Norway | OR230648 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg s.n.* (S F298954) | Sweden | OR230649 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg & L. Williams s.n.* (S F283543) | Spain | OR230650 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg & L. Williams s.n.* (S F283541) | Spain | OR230651 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *E. Timdal 12359* (O L-170859) | Norway | OR230652 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Thalloidima | *Thalloidima sedifolium* | *J.T. Klepsland JK09-L474* (O L-165017) | Norway | OR230653 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *J.T. Klepsland JK11-L357* (O L-177200) | Norway | OR230654 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg et al. GTL49* (S F298913) | Sweden | OR230655 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg et al. 15-081* (S F277996) | Sweden | OR230656 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *M. Westberg & L. Hedenäs 15-239* (S F278002) | Sweden | OR230657 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *J.C. Hughes & E. Timdal 6808* (O L-123) | Italy | OR230658 | - | - |
| Thalloidima | *Thalloidima sedifolium* | *R. Yahr et al. s.n.* (UPS L–794039) | UK | OR230659 | - | - |
| Thalloidima | *Toninia sedifolia* | *T. Knutsson 97-407* (BG-L-39926) | Sweden | AF282120 | - | - |
| Thalloidima | *Thalloidima squamatum* | *E. Timdal & S. Rui 18038b* (O L-223683) | Canada | **PQ219491** | - | - |
| Thalloidima | *Thalloidima squamatum* | *E. Timdal 16089* (O L-204879) | Switzerland | **PQ279268** | - | - |
| Thalloidima | *Thalloidima squamatum* | *E. Timdal & S. Rui 18060* (O L-223707) | Canada | **PQ279256** | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg GYN033* (S F257011) | Sweden | OR230660 | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg & M. Prieto s.n.* (S F283518) | Sweden | OR230661 | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg 08-419* (S F122068) | Sweden | OR230662 | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg s.n.* (S F298917) | Sweden | OR230663 | - | - |
| Thalloidima | *Thalloidima squamatum* | *A. Breili L3647* (O L-167188) | Norway | OR230664 | - | - |
| Thalloidima | *Thalloidima squamatum* | *J.T. Klepsland JK10-L121* (O L-183583) | Norway | OR230665 | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg s.n.* (S F298955) | Sweden | OR230666 | - | - |
| Thalloidima | *Thalloidima squamatum* | *R. Haugan & S. Reiso 8201* (O L-160414) | Norway | OR230667 | - | - |
| Thalloidima | *Thalloidima squamatum* | *J.T. Klepsland JK11-L208* (O L-177140) | Norway | OR230668 | - | - |
| Thalloidima | *Thalloidima squamatum* | *I. Olariaga & M. Prieto s.n.* (UPS L-790192) | Italy | OR230669 | - | - |
| Thalloidima | *Thalloidima squamatum* | *M. Westberg et al. GTL176* (UPS L–793505) | Sweden | OR230670 | - | - |
| Thalloidima | *Toninia taurica* | *R. Haugan & E. Timdal 8060* (O L-15115) | Norway | AF282118 | - | - |

**Table 1 (continued).** Voucher information with GenBank Accession numbers and references in the phylogenetic analysis. New sequences obtained in this study are in bold.

| Dataset | Species | Voucher | Country | ITS | LSU | mtSSU |
|---|---|---|---|---|---|---|
| Thalloidima | *Thalloidima tauricum* | *M. Bendiksby et al. 12920* (O L-184333) | Norway | MG838174 | - | - |
| Thalloidima | *Thalloidima tauricum* | *E. Timdal 13751* (O L-200949) | Spain | MG838203 | - | - |
| Thalloidima | *Thalloidima tauricum* | *E. Timdal 16105* (O L-204893) | Switzerland | **PQ279293** | - | - |
| Thalloidima | *Thalloidima toepfferi* | *T. Tønsberg 42112* (BG-L-94600) | Spain | MG926134 | - | - |
| Thalloidima | *Thalloidima toepfferi* | *R. Haugan 143131* (O L-198902) | Spain | MG926135 | - | - |
| Thalloidima | *Thalloidima toninianum* | *E. Timdal 13773* (O L-200971) | Spain | MG926036 | - | - |
| Thalloidima | *Thalloidima toninianum* | *E. Timdal 16106* (O L-204894) | Switzerland | **PQ279279** | - | - |
| Toninia | *Toninia squalida* | *E. Timdal 13013* (O L-184426) | Norway | MG838181 | - | - |
| Toninia | *Toninia squalida* | *E. Timdal 13126* (O L-184539) | Norway | MG838200 | - | - |
| Toninia | *Toninia tristis* | *J. Hollinger 10644* (BRY) | USA | BOLD:LIMW3879-22 | - | - |
| Toninia | *Toninia tristis* | *S. Leavitt 17-782* (BRY) | USA | BOLD:LIMW3880-22 | - | - |
| Toninia | *Toninia tristis* | *E. Timdal 13033* (O L-184446) | Spain | MG838171 | - | - |
| Toninia | *Toninia tristis* | *R. Haugan 150150* (O L-198907) | Spain | MG926136 | - | - |
| Toninia | *Toninia tristis* | *E. Timdal 16107* (O L-204895) | Switzerland | **PQ279263** | - | - |
| Toninia | *Toninia tristis* | *L. Han LF201308047-1 ITS4* (herbarium unknown) | ??? Unknown | OM065442 | - | - |
| Toninia | *Toninia tristis* ssp. *asiaecentralis* | *E. Timdal & S. Rui 18035* (O L-223679) | Canada | **PQ279266** | - | - |
| Toninia | *Toninia tristis* ssp. *asiaecentralis* | *E. Timdal & S. Rui 18061* (O L-223708) | Canada | **PQ279281** | - | - |
| Toninia | *Toninia tristis* ssp. *asiaecentralis* | *sine coll. "201899728"* (herbarium unknown) | ??? Unknown | OM521966 | - | - |
| Toninia | *Toninia tristis* ssp. *pseudotabacina* | *S. Rui & E. Timdal 18565* (O L-228577) | Spain | **PQ279267** | - | - |
| Toninia | *Toninia tristis* ssp. *scholanderi* | *A. Paukov 2453* (O L-208741) | Russia | **PQ279282** | - | - |
| Toninia | *Toninia tristis* ssp. *tristis* | *E. Timdal & S. Rui 18056* (O L-223703) | Canada | **PQ219492** | - | - |
| Toninia | *Toninia tristis* ssp. *tristis* | *R. Haugan & E. Timdal 8109* (O L-15157) | Norway | AF282105 | - | - |
| Toninia | *Toninia tristis* ssp. *tristis* | *sine coll. "10-0276"* (herbarium unknown) | China | MN103177 | - | - |
| Toninia | *Toninia* sp. | *L. Han LF2019080806-8-ITS805bp* (herbarium unknown) | ??? Unknown | MN839752 | - | - |

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# Additions to the lichens, allied fungi and lichenicolous fungi of Québec, Canada, with emphasis on the area below the 50th parallel

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ABSTRACT. – Records of forty-eight new or noteworthy lichens, allied fungi or lichenicolous fungi from Québec are presented. The majority of specimens were collected during opportunistic field visits and inventories conducted between 2014 and 2023. Additionally, we include previously undocumented specimens, either collected in earlier years or more recently, that have not yet been reported or have been mentioned only once in the literature. The species *Cercidospora epipolytropa*, *Leptorhaphis lucida*, *Naetrocymbe rhyponta*, *Peccania tiruncula*, *Pyrenidium aggregatum*, *Pyrenopsis grumulifera, Tremella flavoparmeliae* and *Trimmatothelopsis dispersa* are new to Canada. Thirty additional species are reported as new to Québec: *Abrothallus microspermus*, *Acarospora rosulata*, *A. subfuscescens*, *Agonimia opuntiella*, *Biatora pontica*, *B. sphaeroidiza*, *Cladonia norvegica*, *Crespoa crozalsiana*, *Endocarpon petrolepidum*, *Epithamnolia pertusariae*, *Heppia adglutinata*, *Heterodermia squamulosa*, *Hypotrachyna showmanii*, *Lecanora nothocaesiella*, *L. poliophaea*, *Micarea misella*, *Muellerella hospitans*, *Ovicuculispora parmeliae*, *Parmelia neodiscordans*, *Parmotrema margaritatum*, *P. perlatum*, *P. reticulatum*, *Phlyctis petraea*, *Physconia grumosa*, *Placidium arboreum*, *Placynthium stenophyllum* var. *isidiatum*, *Punctelia appalachensis*, *P. stictica, Rhizocarpon timdalii* and *Trapeliopsis pseudogranulosa*. Ten additional rare or seldom-collected species are also documented: *Acrocordia cavata*, *Catillaria lenticularis*, *Heterodermia hypoleuca*, *Leproplaca cirrochroa*, *Leptogium rivulare*, *Lithographa tesserata*, *Micarea globulosella*, *Physconia subpallida*, *Rimularia badioatra* and *Umbilicaria hirsuta*. These findings highlight the need for ongoing efforts to deepen our understanding of lichen distributions in southern Québec, a region that remains largely underexplored.

KEYWORDS. – Biodiversity, distribution, range extension, rare species.

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## INTRODUCTION

Québec is the largest Canadian province, covering 1.7 million km², extending from the 45th to the 62nd parallel and encompassing six vegetation subzones, from temperate deciduous forests in the south to low-arctic tundra in the north (Ministère des Forêts, de la Faune et des Parcs 2021; Figure 1 herein). Lichens, known for their ecological roles as bioindicators and contributors to biodiversity, are critical components of these diverse ecosystems. However, despite the vastness and ecological richness of Québec, large portions of the province, particularly those south of the 50th parallel, remain underexplored in terms of lichen diversity.

Although lichen surveys have been conducted in that area, substantial gaps persist in our understanding of this region's lichen biota. Notable studies include early work by Macoun (1898, 1902), Brodo (1988), and more recently Brodo et al. (2021a, 2021b) in the Ottawa region, as well as the surveys of Lepage (1947–1949), which focused on the area between Québec City and the Gaspé Peninsula, and his later work (Lepage 1958, 1972), which covered various regions across Québec. Additionally, researchers such as Sirois et al. (1988), McMullin et al. (2017), Paquette (2019), Paquette and McMullin (2020), and Bell-Doyon (2023) have contributed significantly to documenting lichen diversity in the Gaspé Peninsula and Côte-Nord. Discoveries of lichens new to Québec have also been published by Roy (2000, 2002, 2003), Launis and Myllys (2014), Lavoie (2014), Anderson and Lendemer (2016), McMullin et al. (2016, 2021), and Bell-Doyon et al. (2021). Furthermore, Lavoie (2016, 2017a, 2017b) has documented unpublished reports of new records for Québec, including significant finds from the Monteregian Hills.

Despite these contributions, large areas remain insufficiently studied, and recent discoveries indicate that the lichen flora of Québec is far from fully documented. Here, we aim to address these gaps by reporting new additions to the Québec lichen biota, based on recent fieldwork and previously unpublished herbarium data. These lichens, lichenicolous fungi, and allied fungi were primarily collected in southern Québec, between the 45th and 50th parallels, where forested landscapes dominate. This work not only expands our understanding of the lichen diversity in the province but also underscores the importance of continued exploration and documentation in this under-surveyed region.

By contributing new species records and range extensions, this study helps refine our understanding of the ecological diversity of Québec lichens, providing crucial data for future conservation efforts. Given the critical role that lichens play as environmental indicators, these findings are also important for broader biodiversity assessments and ecosystem monitoring.

## MATERIALS AND METHODS

The species that are the subject of this paper were, for the most part, collected in deciduous and mixed forests. Specimens were collected for identification and to serve as vouchers. For some of the species, *in situ* photographs were taken, while for others, photographs were taken of herbarium specimens. A scale bar was added to photographs taken in the herbarium.

The collected specimens were deposited as vouchers in the following herbaria: Cercle des mycologues de Montréal Fungarium at Université de Montréal (CMMF), Canadian Museum of Nature (CANL), Herbier Louis-Marie at Université Laval (QFA) and New York Botanical Garden (NY). Several books and scientific articles related to the genera discussed in this report were consulted for the identification of the specimens, with the most significant being Hinds and Hinds (2007) for macrolichens and Brodo (2016) for microlichens. Chemical spot tests using sodium hypochlorite, potassium hydroxide 10%, and p-phenylenediamine in 70% ethanol were performed following methods described by Brodo et al. (2001). Specimens that could not reliably be identified by morphology or spot tests alone were confirmed using thin-layer chromatography in solvent system C following Culberson and Kristinsson (1970) and Lendemer (2011).

We consulted the checklist of lichens and allied fungus species for Québec available on "Lichens.Québec" (Lavoie & Collin 2024, continuously updated), to determine if a species was new to the region. Undocumented collections from herbaria, which we considered unpublished, are referred to as records. We classify as 'new' any specimens that have not been previously documented in the literature, regardless of whether they were collected recently or in earlier years. Additionally, rare or seldom-collected lichen species with only a single published occurrence were deemed noteworthy and are also reported. The nomenclature for lichen-forming, lichenicolous and allied fungi follows the 24th edition of the North American Checklist (Esslinger 2021).

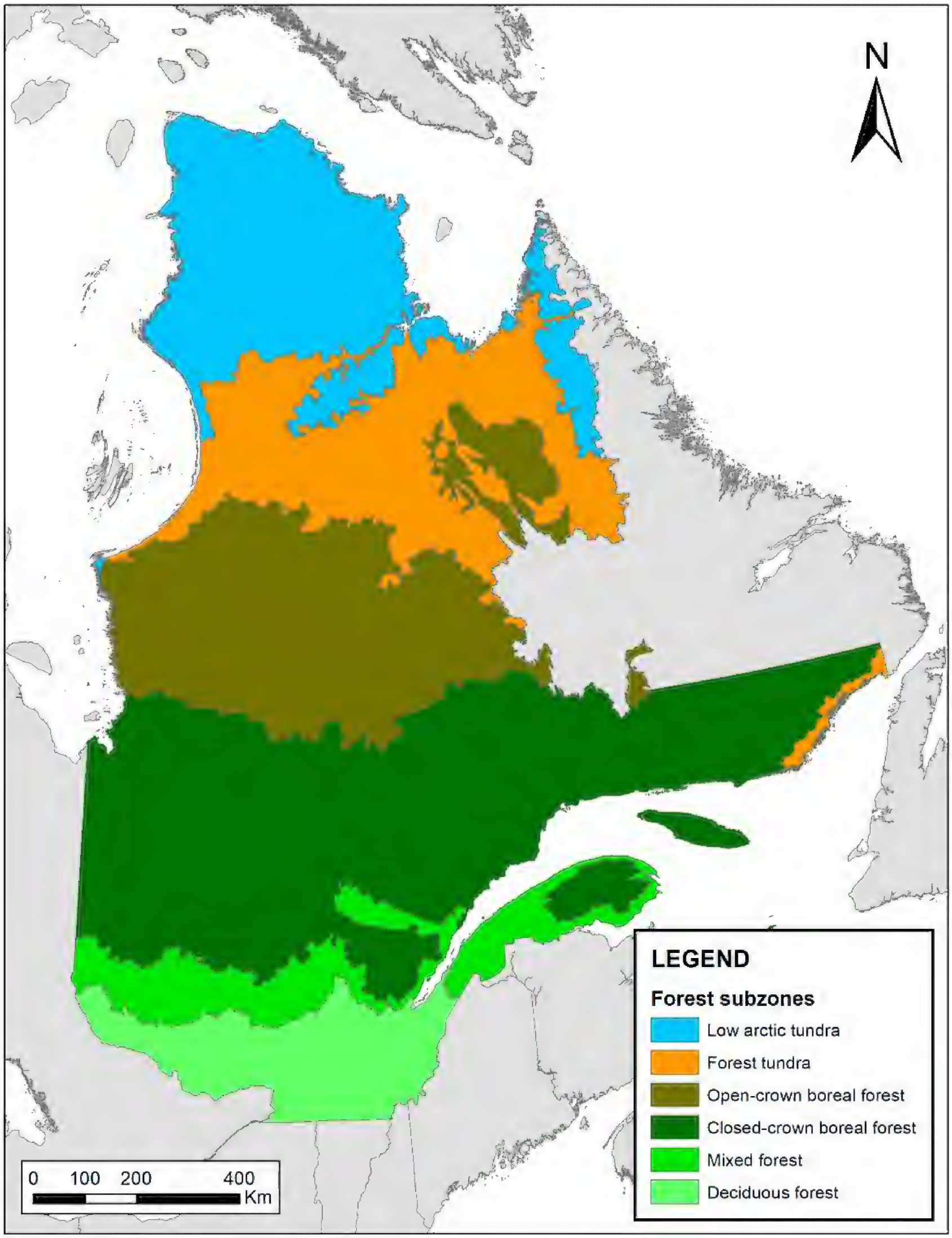


**Figure 1.** Map of the study area illustrating the forest subzones of Québec following Ministère des Forêts, de la Faune et des Parcs (2021).

Throughout specimen citations the acronym MRC, the French acronym for Regional County Municipalities (Municipalité Régionale de Comté), is used. Descriptions of general distributions and habitats for each species are drawn mainly from Brodo et al. (2001), supplemented by consultation of CLH, GBIF, and other specialized works as cited. Distribution maps were created using ESRI ArcGIS 10.5.

## Results and Discussion

In the list below, we document and discuss 48 species from our study area, of which 38 are new to Québec. Eight of these are also new to Canada. The remaining 10 species are interesting as they have rarely been collected in Québec. For Québec or Canada, we considered lichens "noteworthy" if only one previously published report existed. For lichenicolous and allied fungi, we report only new unpublished records. The reports are arranged alphabetically by genus and species. The species that are new to Canada are preceded by two asterisks (**), those new to Québec are preceded by one asterisk (*), and allied and lichenicolous fungi are indicated with a dagger (†).

***†*Abrothallus microspermus* Tul.**

**Figure 2A.**

Notes. – *Abrothallus microspermus* is parasitic on the thallus of *Flavoparmelia caperata* (L.) Hale (Diederich 2004, 2011). The specimen examined exhibited abundant superficial pycnidia. The conidia, measuring 4–6 × 6–8 µm, were truncated and hyaline. Convex black apothecia contained 10–12 × 4–6 µm, two-celled brown spores with cells of unequal size. The name *Vouauxiomyces truncatus* (B. de Lesd.) Dyko & D. Hawksw. was used in the past for the anamorph of this fungus while *A. microspermus* was used for the teleomorph (Hawksworth 1981). They have now been combined and are treated collectively under the name of the teleomorph (Rossman et al. 2016). *Abrothallus microspermus* is widespread in Europe (Brackel 2014), but in North America is known from only a handful of records (Diederich 2003, Cole & Hawksworth 2001, Seaward et al. 2017, Triebel et al. 1991, Tripp & Lendemer 2019). Despite the frequency of *F. caperata* in southern Québec, this is the first report of *A. microspermus* from the province.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, at the edge of a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, lichenicolous on *Flavoparmelia caperata* on *Acer* sp., 1.xii.2021, *J. Collin JC0292* (CMMF, conf. A. Huereca).

***Acarospora rosulata* (Th. Fr.) H. Magn.**

**Figure 2B.**

Notes. – *Acarospora rosulata* is a microlichen usually found on non-calcareous rocks (Knudsen et al. 2010). Its thallus is areolate, becoming distinctly subsquamulose with lobulate areoles (Knudsen et al. 2010). Specimens from Norway often produce many apothecia on a single areole but like the western North American specimens, our specimen has areoles usually with a single apothecium (Knudsen et al. 2010). Due to the presence of gyrophoric acid, the cortex reacts C+ and KC+ producing a reddish color. *Acarospora rosulata* resembles *A. bullata* Anzi, but it differs by lacking large determinate thalli with fan-shaped lobes and distinctly rugulose apothecial discs, which are characteristic of *A. bullata* (Brinker & Knudsen 2019). This is a new record for Québec and eastern North America. In Canada, it is known only from Saskatchewan (CLH 2023). Other records are from Asia, Europe, and western North America (Knudsen et al. 2010).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Le Bic, Cap-Enragé, Parc national du Bic, by the St. Lawrence River, on the shaded side of a schist rock, 23.viii.2016, *A. Lavoie 160823-Z0004* (CMMF).

***†*Acarospora subfuscescens* (Nyl.) H. Magn.**

**Figure 2C.**

Notes. – *Acarospora subfuscescens* is characterized by apothecia that are immersed to superficial, exhibiting a dull black or brownish-black coloration (Knudsen & Kocourková 2008). The apothecial disks appear rough and umbonate, owing to the presence of lumps of carbonized tissue (Brodo 2016). The outer layer of the exciple is carbonized (Knudsen & Kocourková 2008). In our material, the spores measured 4 × 1.5 µm. This lichenicolous fungus grows on various saxicolous crustose host lichens throughout Asia, Europe and North America in the northern hemisphere (Knudsen & Kocourková 2008). In Canada, it has

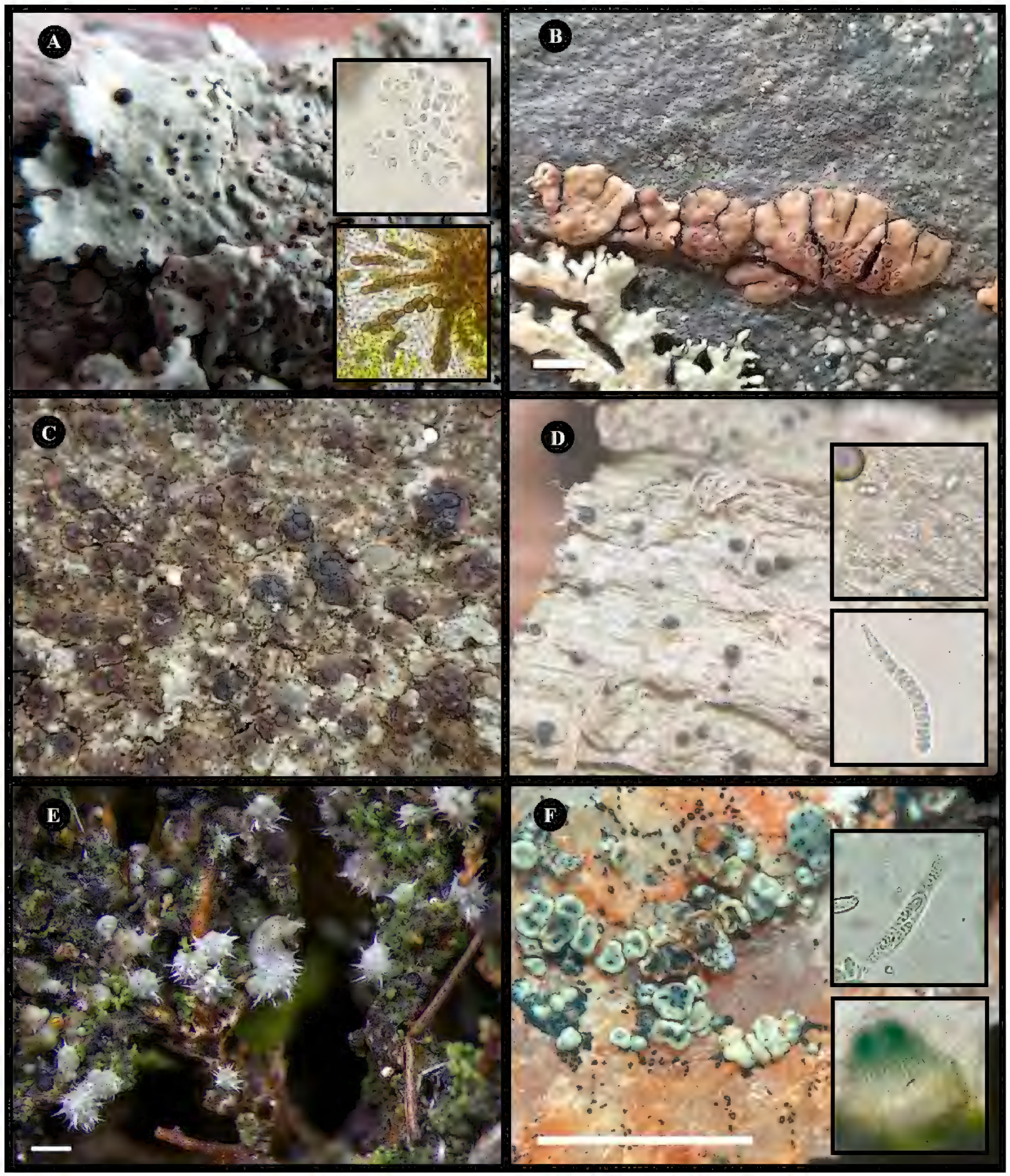


**Figure 2.** Photographs of selected species discussed in this contribution. **A**, *Abrothallus microspermus*, in situ photograph with inset showing hyaline conidia and brown ascospores (*J. Collin JC0292*, CMMF). **B,** *Acarospora rosulata* (*A. Lavoie 160823-Z0004*, CMMF). **C**, *Acarospora subfuscescens*, in situ photograph (*A. Lavoie HCAL15-324*, CMMF). **D,** *Acrocordia cavata*, in situ photograph with insets showing ascospores and uniseriately arranged ascospores in an ascus (*J. Collin JC0463*, CMMF). **E**, *Agonimia opuntiella* (*S. Brinker 9618*, CANL). **F,** *Cercidospora epipolytropa* with insets showing four-spored asci and region near the perithecial ostiole with aeruginose pigment in KOH (*J. Collin JC1188-2*, CMMF). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

been collected from Grasslands National Park in Saskatchewan (Freebury 2014). There is an unpublished record from Vermont (CLH 2023), close to the Québec border.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, on the mountain, open area, in front of the research center, lichenicolous on an unidentified lichen thallus on the horizontal surface of a silicious rock, 10.vi.2015, *A. Lavoie HCAL15-324* (CMMF).

***Acrocordia cavata* (Ach.) R.C. Harris**

**FIGURE 2D.**

NOTES. – *Acrocordia cavata* is a corticolous gray-white crustose lichen with black perithecia and distinctive uniseriately arranged spores in the asci (Purvis & Orange 2009). The spores of our specimen are 1-septate, measuring 12.5–16.25 × 6–10 µm. *Anisomeridium biforme* (Borrer) R.C. Harris is similar in appearance but it has spores with a smooth perispore instead of a verrucose perispore (Harris 2015). *Acrocordia cavata* is known from Québec on the basis of only two unpublished historical records (CLH 2023: MRC de la Côte-de-Gaspé, 1882, *J. Macoun 3250*, CANL[n.v.]; MRC La Mitis, 1959, *S. Shushan S23179*, COLO[n.v.]). The following records reconfirm its presence in Québec.

*Specimens examined*. – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Saint-Anaclet, Sentier National, Chute Neigette sector, close to the footbridge, on *Thuja occidentalis*, 28.vi. 2022, *J. Collin JC0463* (CMMF); Saint-Marcellin, on *Populus* sp., 28.vi.2022, *A. Lavoie 220628-Z1521* (CMMF); on *Thuja occidentalis*, 28.vi.2022, *A. Lavoie 220628-Z1520* (CMMF).

***Agonimia opuntiella* (Buschardt & Poelt) Vězda**

**FIGURE 2E.**

NOTES. – *Agonimia opuntiella* is a minutely squamulose lichen that is terricolous or corticolous on mosses or over lichens (Breuss 2002). It is composed of distinctly segmented, minute, greenish to brownish squamules, with hyaline cortical hairs and marginal ellipsoid to subglobose blastidia (Breuss 2002; Łubek 2012). It is usually sterile (Breuss 2002), and perithecia were not observed in our material. Although uncommon, it can be found throughout eastern North America (Tripp & Lendemer 2020). Here it was found on mosses over limestone and over *Placidium arboreum* (Schw. ex Tuck.) Lendemer.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Thuja occidentalis* deciduous forest with limestone outcrops, over mosses on limestone boulder, growing over *Placidium arboreum*, 06.x.2022, *S. Brinker 9618* (CANL).

***Biatora pontica* Printzen & Tønsberg**

NOTES. – *Biatora pontica* is characterized by a thallus and soredia that react C+ orange (due to the presence of xanthones). In contrast, among other sorediate species of *Biatora* in eastern North America, such as *B. printzenii* Tønsberg, *B. appalachensis* Printzen & Tønsberg, and *B. chrysantha* (Zahlbr.) Printzen, the reaction is typically C+ red-rose, due to the presence of gyrophoric acid (Printzen & Tønsberg 2004). *Biatora pontica* is often sterile (Printzen & Tønsberg 2004). The closest known occurrences are from the states of Vermont and Maine (CLH 2023, Seaward et al. 2017).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DU GRANIT: Notre-Dame-des-Bois, Parc national du Mont-Mégantic, in a yellow birch stand, on *Betula alleghaniensis*, 29.v.2016, *A. Lavoie 160529-MM14C* (CMMF, det. I.M. Brodo).

***Biatora sphaeroidiza* (Vainio) Printzen & Holien**

NOTES. – *Biatora sphaeroidiza* is an oceanic species, similar in appearance to *Micarea peliocarpa* (Anzi) Coppins & R. Sant., but its spores are non-septate and much smaller (Dillman et al. 2012). In Canada, this species has been reported from Newfoundland (Dillman et al. 2012). A search on CLH (2023) showed that there are also records not documented in the literature from New Brunswick and Prince Edward Island. In our specimen, the thallus is creamy yellowish, areolate, K–, KC+ orange due to the presence of thiophanic acid and asemone, the apothecia are 0.2–0.4 mm diameter, flat to slightly convex, and black with margins that are thin, even with disk to slightly prominent, the epihymenium is brown, granular (POL+), the hypothecium is hyaline, POL+ in part and the exciple is biatorine, green within, hyaline at edge and below, gelatinous prosoplectenchym, the hymenium is greenish, 40–45 µm high with pigments and granules disappearing in KOH, and the asci are clearly *Biatora*-type in K/I, with spores that are narrowly ellipsoid, simple, and measuring 9.0–10.9 × 2.5–3.2 µm.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC LA CÔTE-DE-GASPÉ: Gaspé, Parc national Forillon, Cap Gaspé, on windswept heath at point on exposed headland, on trunk of *Picea glauca*, 14.vi.1975, *I.M. Brodo 20767* (CANL).

***Catillaria lenticularis* (Ach.) Th. Fr.**

NOTES. – *Catillaria lenticularis* resembles *C. chalybeia* (Borrer) A. Massal. but differs in having a pale exciple or one that is dark-colored only at the outer edge, rather than a black proper exciple (Cannon et al. 2022). Additionally, its hypothecium is colorless to straw-colored, in contrast to the black color observed in *C. chalybeia* (Cannon et al. 2022). In our specimens, the thallus is granular and khaki green, the exciple is brown while the hymenium is hyaline, the epihymenium and hypothecium are brownish, with two-celled, hyaline spores measuring 7.5–10 × 2.5 µm. It can be found on limestones, other calcareous rocks and some artificial substrata (Cannon et al. 2022, Hertel et al. 2007). The species is already known in Canada from Ontario, Newfoundland and British Columbia, this is the second report for Québec (Brodo et al. 2021b).

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Le Bic, Parc national du Bic, Anse à Wilson, N end of beach, on conglomerate, 7.vii.2013, *F. Anderson 16127* (QFA, det. J.C. Lendemer); Le Bic, Cap-Enragé, Parc national du Bic, on block of conglomerate, back to the sea, 23.viii.2016, *A. Lavoie* 160823-*Z0142* (CMMF); Saint-Fabien, Îlet au Flacon, Parc national du Bic, maritime shore, on the edge of a field of rock boulders, on vertical, dry and exposed conglomerate rock, 21.viii.2017, *J. Gagnon SF12-4901,* (QFA, det. A. Fryday), on sheltered, dry and shaded face of an inclined schistous projection, 21.viii.2017, *J. Gagnon SF12-4902,* (QFA, det. A. Fryday).

****†Cercidospora epipolytropa* (Mudd) Arnold**

**FIGURE 2F.**

NOTES. – *Cercidospora epipolytropa* is a pyrenocarpous lichenicolous fungus primarily found on *Lecanora polytropa* (Hoffm.) Rabenh. (Hawksworth et al. 2010). The specimen reported here was infecting the apothecia of *L. polytropa* and had four-spored asci, instead of eight, which is a character known to occur when the species is found at lower elevation localities (Navarro-Rosinés et al. 2004). The region near the ostiole is aeruginose in KOH, as reported by Hawksworth et al. (2010). In our material the spores are 18–20 × 4–6 µm, hyaline, two-celled and spindle-shaped with one attenuated end more pronounced than the other. This is a common species in Europe but with only a few published records in North America (Brackel 2014), where it is known from the central and western United States (Triebel et al. 1991, Calatayud et al. 2013), Alaska (Spribille et al. 2023), and Greenland (Alstrup et al. 2009).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC LA HAUTE-CÔTE-NORD: Tadoussac, Pointe-Rouge, cape bordering the St. Lawrence River, near the mouth of the Saguenay, on exposed red granite, lichenicolous on *Lecanora polytropa*, 12.viii.2023, *J. Collin JC0963 & A. Lavoie* (CMMF).

***Cladonia norvegica* Tønsberg & Holien**

NOTES. – *Cladonia norvegica* has farinose-sorediate, fine-tipped podetia without cups, and finely incised basal squamules (Tønsberg & Holien 1984). It is similar morphologically to the much more common *C. coniocraea* (Flörke) Spreng, but produces barbatic acid (P−, UV+ dull blue-white), not fumarprotocetraric acid (P+ red, UV-) as in the latter species. Its most distinctive feature, not always conspicuous, is the presence of spots of reddish pigment in exposed areas of the medulla (Pino-Bodas et al. 2021). It has been suggested that the production of red pigment (rhodocladonic acid) in this species is a defense against mite predation (Timdal 1989). *Cladonia norvegica* could also be confused with the barbatic acid chemotype of *C. macilenta* Hoffm., but that species has more blunt-tipped podetial with red apothecia. Apothecia are rare in *C. norvegica*, and reportedly "pale brown" (Brodo 2016) or "ochraceous or pinkish" (Pino-Bodas et al. 2021). It is found in swampy forests, on tree bases or rotten trees (Stenroos et al. 2016). In Canada, it ranges across six provinces, from Newfoundland to British Columbia (CLH 2023, GBIF 2023, McMullin & Lewis 2014, McMullin et al. 2015, Schram et al. 2013, Tønsberg & Goward 1992).

*Specimens examined.* – **CANADA. QUÉBEC**. ADMINISTRATION RÉGIONALE KATIVIK: Nunavik, 145 km WNW of Kawawachikamach, high shoreline of a small pond with basic rocks, north bank, south-facing; beginning of a shrubby area, on the root of a dead *Picea mariana*, 27.vii.2012, *J. Gagnon 40* (QFA, det. C. Roy). MRC DE LA VALLÉE-DU-RICHELIEU : Saint-Denis-sur-Richelieu, Réserve naturelle du Bois-des-Patriotes, in a forested peatland, on *Picea rubens*, 17.viii.2015, *A. Lavoie 150817-Z0212* (CMMF).

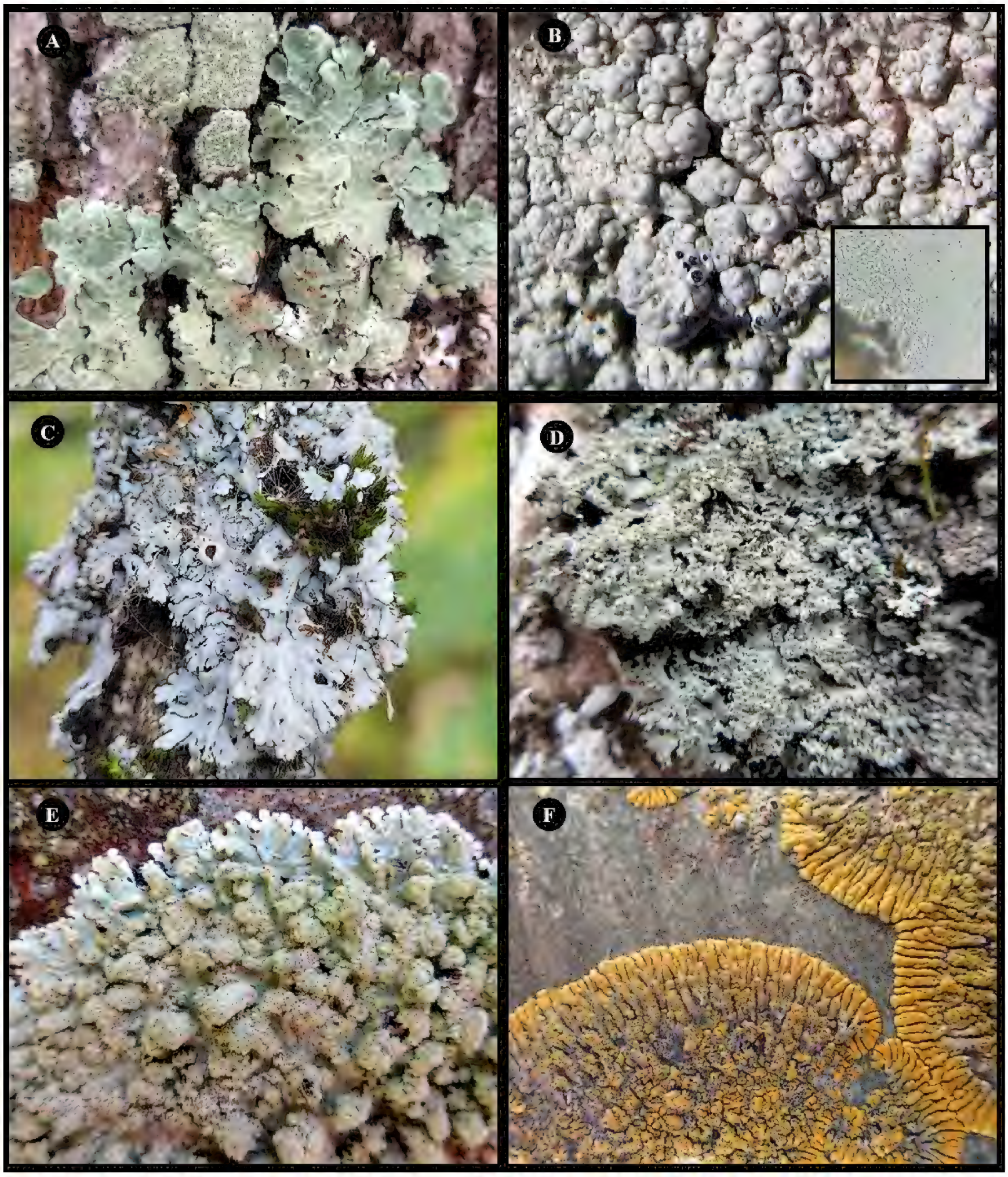


**Figure 3.** Photographs of selected species discussed in this contribution. **A**, *Crespoa crozalsiana* in situ photograph (*J. Collin JC0026*, CMMF). **B**, *Epithamnolia pertusariae*, in situ photograph with inset showing curved ascospores (*J. Collin JC0080*, CMMF). **C**, *Heterodermia hypoleuca*, in situ photograph (*S. Brinker 9621*, CANL). **D**, *Heterodermia squamulosa*, in situ photograph (*J. Collin JC0017*, NY). **E**, *Hypotrachyna showmanii*, in situ photograph by J. Collin (*A. Lavoie 201112-Z1344*, CMMF). **F**, *Leproplaca cirrochroa* (*A. Lavoie 230705-Z1531*, CMMF). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

***Crespoa crozalsiana* (B. de Lesd. ex Harm.) Lendemer & Hodkinson**

**FIGURE 3A.**

NOTES. – *Crespoa crozalsiana* is a corticolous foliose lichen recognized by its gray-green thallus with reticulate ridges with soredia, its white medulla containing stictic acid, and its black lower surface, grading to brown at the margins (Flenniken 1999). It may be confused with the much more common *Myelochroa aurulenta* (Tuck.) Elix & Hale, but in that species, the lobes are smooth and without maculae, the medulla is slightly yellow, and stictic acid is lacking (Brodo et al. 2001). In North America, *C. crozalsiana* occurs widely in temperate areas of the eastern United States and also in the southwest (Lendemer & Noell 2018, McMullin 2023, Nash & Elix 2002). It was only very recently reported from Canada in Ontario (McMullin et al. 2021).

*Specimens examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, at the edge of a swamp predominantly with conifers, on conifer bark, 8.i.2021, *J. Collin JC0026* (CMMF, det. A. Lavoie); Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 8.xii.2021, *J. Collin JC0293* (CMMF, det. A. Lavoie), 30.xii.2021, *J. Collin JC0301* (CMMF, conf. R.T. McMullin).

***Endocarpon petrolepideum* (Nyl.) Nyl.**

NOTES. – *Endocarpon petrolepideum* is a squamulose lichen found on calcareous rocks, mortar, concrete, pebbles and clam shells (Lendemer 2007). The thallus of *E. petrolepideum* differs from that of *E. pallidulum* (Nyl.) Nyl. in having much smaller orbicular squamules, which are either continuous or dispersed and tend to be only somewhat lobed (Lendemer 2007). Moreover, the squamules of *E. petrolepideum* are typically tightly adnate and evenly attached to the substrate and the overall color of the thallus is predominantly dark chocolate brown to gray-brown, contrasting with the pale tan to tan-brown hue observed in *E. pallidulum* (Lendemer 2007). It is widely distributed in North America but in Canada has only been reported from Alberta and Ontario (Lendemer 2007). It was previously collected from a single site in Québec in the MRC Brome-Missisquoi in 2016 by Richard Harris (*R.C. Harris 61505*, NY[n.v.]), but that record was not published.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, south face of the mountain, escarpment behind Réserve naturelle Gault parking lot, on rock, 31.xiii.2014, *A. Lavoie HCAL-997* (CMMF, det. R.C. Harris).

***†*Epithamnolia pertusariae* (Etayo & Diederich) Diederich & Suija**

**FIGURE 3B.**

NOTES. – This lichenicolous fungus was discovered growing on an unidentified corticolous *Pertusaria* species, which we could not identify due to the absence of spores. The non-septate conidia observed were needle-like in shape, measuring no more than 20 × 2 µm, consistent with Hawksworth et al. (2010). These conidia originated from conidiomata ranging between 100 and 160 µm in size. Known in Canada from the High Arctic in Nunavut, with other records from Europe (Suija et al. 2017), this is the second record for Canada and North America. It is currently not on the North American Checklist (Esslinger 2021).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, lichenicolous on *Pertusaria* sp., 20.iii.2021, *J. Collin JC0080* (CMMF, det. A. Huereca).

***Heppia adglutinata* (Kremp.) A. Massal**.

NOTES. – *Heppia adglutinata* is a brown to yellow-olive squamulose cyanolichen with immersed reddish-brown apothecia (Hinds & Hinds 2007). The spores of our specimen are one-celled, hyaline, and ellipsoid, measuring 15.5–17.5 x 7–8 µm, the cyanobacterial algal cells are 10–13 µm, the epihymenium is brown, the hymenium initially reacts IKI+ green, then shifts to reddish-orange. In Canada, this limestone-dwelling species was only known from Ontario, where it was first reported from globally rare alvars on the Bruce Peninsula (Brodo et al. 2013). It has since been found to be more widespread in the province (Brinker 2020, Lewis & Brinker 2017). This is a significant north and east range extension for this species.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DE LA MINGANIE: Île d'Anticosti, edge of the Wickenden Rd., about 1 km from the fork leading to Lac Wickenden, low shrubby *Picea mariana* stand with lichens and lots of pebbles outcropping, on thin sandy-loamy mineral deposit on a rocky outcrop, 18.vii.2005, *C. Roy 05-5496-C & L. Filion* (QFA, det. I.M. Brodo).

***Heterodermia hypoleuca* (Muhl.) Trevisan**

**FIGURE 3C.**

NOTES. – *Heterodermia hypoleuca* is a widespread temperate eastern North American lichen (Lendemer 2009) with an Appalachian-Great Lakes distribution (CLH 2023). It occurs on the bark of various hardwoods (Lendemer 2009). It is the only non-sorediate species in the genus without marginal cilia that commonly produces apothecia and occurs in Québec. Until recently, the few known Canadian occurrences of *H. hypoleuca*, which included several from southern Québec, were historical. The species was listed as possibly extirpated (Goward et al. 1998) but recent Canadian collections have reconfirmed its presence (Lewis & Brinker 2017; Brinker 2020). It was listed as a high priority candidate at-risk species in Canada (COSEWIC 2019) and is currently the subject of a federal status assessment to determine its national status. A search of CLH (2023) showed previous records from the MRC du Haut-Richelieu (1958, *F. Leblanc 8725*, QFA[n.v.]), MRC de Brome-Missisquoi (2016, *R.C. Harris 61528*, NY[n.v.]), and MRC de la Vallée-de-la-Gatineau (date unknown, *A. Hanes s.n.*, CANL[n.v.] 96112).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Pinus strobus* deciduous forest with limestone outcrops, on fallen *A. saccharum*, 06.x.2022, *S. Brinker 9621* (CANL).

***Heterodermia squamulosa* (Degel.) W.L. Culb.**

**FIGURE 3D.**

NOTES. – *Heterodermia squamulosa* is found on the bark of hardwood trees and has a gray foliose thallus made distinctive with its minute marginal phyllidia or lobules (Lendemer 2009). In North America, it is known primarily from the central and southern Appalachian Mountains with populations occurring in the Atlantic Maritime Ecozone of eastern Canada (Anderson 2014, Clayden 2010). Details of an unpublished record from the Lac St-Jean region (*F. Lutzoni & N. Dignard 840718-L138*, QFA[n.v.]) are posted on CLH (2023). However, we have been unable to locate that voucher specimen at QFA.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 30.xii.2020, *J. Collin JC0017* (NY, conf. J.C. Lendemer).

***Hypotrachyna showmanii* Hale**

**FIGURE 3E.**

NOTES. – *Hypotrachyna showmanii* is a corticolous foliose lichen species (Hale 1976). Of the pustulose species of *Hypotrachyna* in eastern North America, it can be recognized by its coarse pustules that tend to remain intact and do not readily fragment into schizidia or form soredia, by the usually adnate lobes with a network of minute reticulate maculae at lobe tips and by the production of gyrophoric acid with 3-methoxy-2,4-di-O-methylgyrophoric acid and 2,4-di-O-methylgyrophoric acid (Hale 1976, Lendemer & Allen 2020). Although first described by Hale (1976) and considered rare, *H. showmanii* was found to be widely distributed in the Mid-Atlantic region by Lendemer and Harris (2006), and shown to be even more widespread in temperate eastern North America by Lendemer & Allen (2020). In Canada, it was recently reported from Ontario (Brinker 2023).

*Specimens examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, near a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Acer rubrum*, 12.xi.2020, *A. Lavoie 201112-Z1344 & J. Collin* (CMMF, conf. R.T. McMullin); Glen-Sutton, Au Diable Vert, in a swamp, on deciduous tree, 13.v.2022, *A. Lavoie 220513-*Z1219 *& J. Collin* (CMMF), on *Tsuga canadensis,* 13.v.2022, *A. Lavoie 220513-Z1248 & J. Collin* (CMMF); Lac-Brome, near a swamp with *Fraxinus pennsylvanica, Acer rubrum* and *Thuja occidentalis*, on *Acer rubrum*, 23.v.2022, *J. Collin JC0431* (CMMF, conf. A. Lavoie), 22.x.2022, *J. Collin JC0692 & A. Lavoie* (CMMF, det. A. Lavoie).

***Lecanora nothocaesiella* R.C. Harris & Lendemer**

NOTES. – *Lecanora nothocaesiella* is a sorediate sterile lichen endemic to North America and found on the bark of hardwood trees (Tripp & Lendemer 2020). It can easily be confused with *Lepraria caesiella* R.C. Harris from which it derives its name. *Lecanora nothocaesiella* has a blue-gray thallus that initially has discrete soralia, while *L. caesiella* has a truly leprose thallus (Lendemer et al. 2013). Both species contain atranorin and zeorin (K+ yellow, C–, UV–), but *L. caesiella* has a fatty acid (pallidic acid) in addition to those substances (Lendemer 2013, Lendemer et al. 2013).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC RIVIÈRE-DU-NORD: St.-Hippolyte, in a young stand of *Fraxinus nigra* with *Abies balsamea*, on the trunk of *Fraxinus nigra*, 03.vi.2013, *J. Gagnon 116b-9* (QFA, det. J.C. Lendemer).

***Lecanora poliophaea* (Wahlenb.) Ach.**

NOTES. – Based on his personal observations of Haida Gwaii material (Brodo 2010), the fifth author notes that *Lecanora poliophaea* is characterized by a verrucose to verruculose, pale to dark gray, or brownish-gray thallus, with K–, C–, and KC– reactions (lacking atranorin and xanthones). The distinctly red-brown apothecia have prominent, thallus-colored margins and a distinct amphithecial cortex, 25–60 µm thick, and the red-brown epihymenium lacks any granules (POL-). The hyaline spores are (8–)9–15 × 4.5–7 µm, 8 per ascus. Few other *Lecanora* species have such a well-developed K– thallus with red-brown apothecia. *Lecanora poliophaea* is characteristically found on shoreline rocks, mostly maritime non-calcareous rocks (Brodo 2010) but it has also been reported from lakeshores in Europe (Cannon et al. 2022). Although not uncommon in the Pacific Northwest, in eastern Canada it has only been previously collected on the Avalon Peninsula of Newfoundland (Brodo 2010).

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE CHARLEVOIX-EST: La Malbaie, Centre écologique de Port-au-Saumon, end of Habenaria trail, on shoreline rocks, with maritime influence from the St. Lawrence Estuary, 30.vi.1997, *I.M. Brodo 29397* (CANL), on vertical shoreline rock walls, *C. Roy et al. 0499488-C* (QFA, det. I.M. Brodo).

***Leproplaca cirrochroa* (Ach.) Arup, Frödén & Søchting**

**FIGURE 3F.**

NOTES. – *Leproplaca cirrochroa* (≡ *Caloplaca cirrochroa* (Ach.) Th. Fr.) is found on calcareous rocks (Wetmore & Kärnefelt 1998). It is characterized by its lobate thallus firmly attached to the substrate, and greenish to yellowish orange excavate soralia originating laminally from the center of the thallus (Wetmore & Kärnefelt 1998). In North America it is most commonly found east of the Rocky Mountains and was mapped from a single location in central Québec by Wetmore and Kärnefelt (1998). A CLH search revealed six collections all made on the same day in 1983 in the MRC de Rimouski-Neigette (*F. Lutzoni 11352-L6* in CANL[n.v.]; *Zoladeski 11356-L6, 11352-L1, 11352-L1-L5, 11370-L1-L2*, all in QFA[n.v.]). The collections cited here are only the second and third published records for the province.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Thuja occidentalis* deciduous forest with limestone outcrops, on limestone rock face, 06.x.2022, *S. Brinker 9615* (CANL). MRC DE RIMOUSKI-NEIGETTE: Saint-Fabien, Ilet au Flacon, Parc national du Bic, on schist above high tide mark, facing N across St. Lawrence River, 05.vii.2023, *A. Lavoie 230705-Z1531* (CMMF).

***Leptogium rivulare* (Ach.) Mont.**

NOTES. – *Leptogium rivulare* is a foliose cyanolichen distinguished by its smooth, blue-gray lobes, numerous small apothecia, and asci containing four spores each (Jørgensen 2012a). It is currently listed as a species at risk in Canada (Environment Canada 2013). Major threats to its survival are the disappearance of ashes (*Fraxinus* spp.) due to the Emerald Ash Borer (*Agrilus planipennis*), ash trees being an important host for *L. rivulare* (Brodo et al. 2021a), and drier conditions due to climate change as it has a requirement for periodic flooding (COSEWIC 2015). It is found mainly in Ontario, with two known occurrences in southwest Québec. This additional record extends its range 625 kilometers northeast of its known range.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Le Bic, Parc national du Bic, Le Contrebandier trail, at the edge of a small swampy area, on the base and roots of a mature *Populus*, 05.viii.2015 *F. Anderson 16346* (QFA).

****Leptorhaphis lucida* Körber**

**FIGURE 4A.**

NOTES. – *Leptorhaphis lucida* grows exclusively on the bark of *Populus* (Aguirre-Hudson 1991). Its spores are colorless, fusiform, slightly curved, longer than 45 µm, and its hymenium gel is IKI- (Aguirre-Hudson 1991). In our specimens the spores averaged 48–58 × 3–3.5 µm. This is a new species for Canada and a second record for North America. The first record was collected on *Populus* in Michigan in 1971 (Aguirre-Hudson 1991).

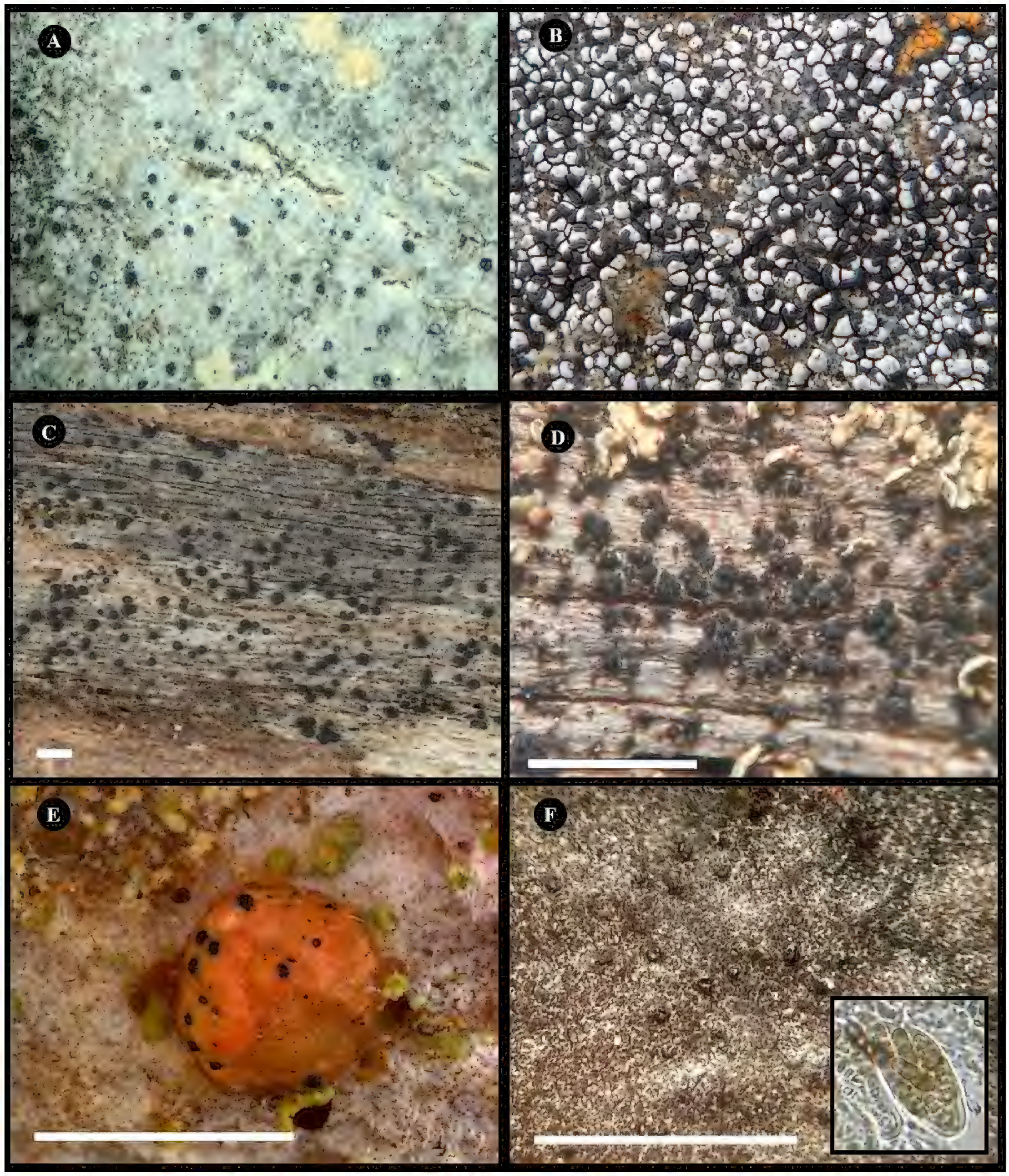


**Figure 4.** Photographs of selected species discussed in this contribution. **A**, *Leptorhaphis lucida*, in situ photograph (*A. Lavoie 160711-Z0488*, CMMF). **B**, *Lithographa tesserata* (*J. Gagnon 2011-25.1a*, QFA). **C**, *Micarea globulosella* photograph by K. Damboise (*C. Roy 0504267*, QFA). **D**, *Micarea misella*, photograph by J. Collin (*A. Lavoie Z0561*, CMMF). **E**, *Muellerella hospitans* (*R.T. McMullin 18880*, CANL). **F**, *Naetrocymbe rhyponta*, with inset photograph by J. Collin showing three-septate ascospores in an ascus (*A. Lavoie HCAL15-050-2*, CMMF). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, Réserve naturelle Gault, in a meadow, on *Populus tremuloides*, 11.vii.2016, *A. Lavoie 160711-Z0488* (CMMF), *A. Lavoie 160711-Z0489* (CMMF).

***Lithographa tesserata* (DC.) Nyl.**

**FIGURE 4B.**

NOTES. – *Lithographa tesserata* is a saxicolous species with narrow and elongated apothecia in which the disc is slit-like (Thomson 1997). The white thallus is characterized by the presence of norstictic acid, and the spores are simple (Thomson 1997). The first initial North American report was from Parc national de la Gaspésie in Québec by Sirois et al. (1988); however, we have been unable to locate a supporting herbarium specimen for this record. Subsequently, the species has been identified in other regions, including British Columbia (McCune 2017), Alaska (Flock 1989), and Maine (Fryday 2006). Seven new occurrences from Québec are reported here.

*Specimens examined.* – **CANADA. QUÉBEC.** ADMINISTRATION RÉGIONALE KATIVIK: Monts de Puvirnituq, 91.7 km W of the village of Kangiqsujuaq, 3.8 km S of Lac Fleury, mid-slope, on partially sheltered rock, 24.vii.2011, *J. Gagnon 2011-25.1a* (QFA, det. P.Y. Wong); 88.9 km NNE of the village of Kangirsuk, 8.5 km NNE of Lac Ammaluttuq, about 1 km W of Étangs Atanirtuut, tundra, on small dry and exposed boulder, 26.vii.2015, *J. Gagnon 56.1b.3* (QFA, det. C.R. Björk and G. Tagirdzhanova). EEYOU-ISTCHEE BAIE-JAMES: Monts Otish, 5.0 km E of Lac Kaanapiteyaapiskaa (Lac Carmen), 1.3 km W of Lac Wepaasiu, dry and exposed sector with frostbite, on gravel, 23.vii.2009, *J. Gagnon 2009-59.2* (QFA, det. A. Fryday). MRC LA MATANIE: Parc national de la Gaspésie, between Monts Dodge and Logan, on low rocky, dry and exposed notch at the edge of Bassin de Pease, 03.vii.2013, *J. Gagnon 2013-11.1* (QFA, det. A. Fryday). MRC DE LA HAUTE-GASPÉSIE: Parc national de la Gaspésie, Mont de la Table, 9.9 km ENE of Gîte-du-Mont-Albert, exposed summit, on a small boulder in a field of exposed boulders, 02.viii.2014, *J. Gagnon 2014-MT-2b* (QFA, det. R.C. Harris). MRC MANICOUAGAN: Réserve de biodiversité Uapishka, Monts Groulx, 3.7 km E of Route 389, Prospecteur massif, north summit, rocky notch near the summit, on thin gravel on rock, 21.vii.2015, *J. Gagnon 2015-160.1* (QFA). MRC CANIAPISCAU: Réserve de biodiversité Uapishka, Monts Groulx, Mont Harfang, 1.9 km E of Route 389, high slope, near the summit, on fine gravel, 23.viii.2015, *J. Gagnon 2015-174.2a* (QFA).

***Micarea globulosella* (Nyl.) Coppins**

**FIGURE 4C.**

NOTES. – *Micarea globulosella* is a crustose lichen that grows mainly on conifer bark (Coppins 2009). The long, nearly acicular or rod-shaped spores (measuring 20 x 3 µm in our specimen), along with the K+ violet reaction of the epithecium, distinguish this species from the similar species *M. denigrata* (Fr.) Hedl. and *M. nitschkeana* (J. Lahm ex Rabenh.) Harm. (Coppins 2009). This is the second known occurrence of *M. globulosella* in Québec. It was first collected in the Mégantic region in the MRC du Granit in 1981 (*C. Nuyt 9963*, QFA[n.v.]). This latter occurrence was probably the basis of a report of *M. globulosella* for Québec by Coppins (1983). In Canada, the species is also present in New Brunswick and British Columbia (CLH 2023).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DE LA MINGANIE: Île d'Anticosti, E of the road that leads to Lac Wickenden, on trunk of *Populus tremuloides*, 60 cm in diameter covered with epiphytes up to the top, on rotten lignin scar, 18.vii.2005, *C. Roy 05-5523-C & L. Filion* (QFA, det. P.Y. Wong).

****Micarea misella* (Nyl.) Hedl.**

**FIGURE 4D.**

NOTES. – *Micarea misella* is similar to *M. denigrata* but usually has an immersed thallus and simple spores (Fryday & Coppins 2007), the latter measuring 6.7–7.7 × 2.7–2.9 µm in our specimens. It is further characterized by strongly convex apothecia, an epihymenium that exhibits a pale violet reaction in KOH, a hyaline hypothecium, and microconidia that occur in immersed pycnidia (Fryday & Coppins 2007). It can usually be found on conifer wood (Fryday & Coppins 2007) and is known from five Canadian provinces (CLH 2023, Freebury 2014, McMullin 2018, McMullin et al. 2018).

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE PAPINEAU: Lac Clair, along road, through *Acer saccharum* stand, Lac Clair, on fence rail, 07.vii.1986, *I.M. Brodo 25292 & L.M. Ley, P.Y. Wong* (CANL). MRC DE LA VALLÉE-DU-RICHELIEU: Saint-Denis-sur-Richelieu, Réserve naturelle du

Bois-des-Patriotes, on dead wood (conifer) on peat soil, 3.vi.2015, *A. Lavoie Z0561* (CMMF, conf. I.M. Brodo). MRC DU GRANIT: Notre-Dame-des-Bois, Parc national du Mont-Mégantic, Mont Mégantic summit, on snag, 30.v.2016, *A. Lavoie 160530-Z0562* (CMMF).

***†*Muellerella hospitans Stizenb.**

**FIGURE 4E.**

NOTES. – *Muellerella hospitans* is characterised by its hosts, species of *Bacidia* and *Biatora*, its asci with 150–300-spores, and subglobose spores that are brown, two-celled and measure 2.5–3.5(–4) × (1.5–) 2–2.5 µm (Brodo et al. 2013, Cole & Hawksworth 2001, Spribille et al. 2010). It was reported for the first time in North America from Minnesota (Cole & Hawksworth 2001). Subsequently it has also been reported from Ontario (Brodo et al. 2013, Brinker 2023) and Alaska (Spribille et al. 2010). This is the second report from Canada.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DES COLLINES-DE-L'OUTAOUAIS: Gatineau Park, Trail 40, 435 m S of Meech Lake, lichenicolous on *Bacidia rubella*, 23.x.2021, *R.T. McMullin 18880* (CANL).

***Naetrocymbe rhyponta* (Ach.) R.C. Harris**

**FIGURE 4F.**

NOTES. – This rarely collected species is usually found on *Populus tremuloides* bark (Aptroot 2002, Harris 1995) and has a north temperate distribution (Aptroot 2002). Its three-septate spores are initially hyaline, becoming brown with age, and measured 14–19 × 6–8 µm in our specimen. Based on CLH (2023), there are scattered occurrences within the United States, notably in Arizona, Florida, Massachusetts, Michigan, North Carolina, Washington, and West Virginia. However, most documented occurrences are concentrated in Europe. According to Nimis (2023), it is probably non-lichenized.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, young forest next to the old research center, on *Populus tremuloides* 15.v.2015, *A. Lavoie HCAL15-050-2* (CMMF, conf. R.C. Harris).

***†*Ovicuculispora parmeliae (Berk. & M.A. Curtis) Etayo**

**FIGURE 5A.**

NOTES. – This lichenicolous fungus produces pink to orangish perithecia that develop a loose, cottony coating of hyphae and grows on a wide variety of host lichens (Flakus et al. 2019). It is characterized by the asci that produce one or two macrospores along with four microspores in the same ascus (Flakus et al. 2019). In our specimen, the two types of two-celled, hyaline spores measured 4 × 10–12 µm and 16–20 × 30–50 µm respectively, with the macrospores showing constrictions at the septa. In Canada, this species is known from Nova Scotia and Ontario (Brinker 2020, Brodo et al. 2013, CLH 2023). In Québec, there are several unpublished records from close to the southern border all based on collections made in 2016 (*W.R. Buck 63909*, NY[n.v.]; *R.C. Harris 61500-D,* NY[n.v.]; *R.C. Harris 61532-A*, NY[n.v.]).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, at the edge of a mixed forest, lichenicolous on *Parmelia sulcata*, 20.xi.2021, *J. Collin JC0289* (CMMF, conf. A. Huereca).

***Parmelia neodiscordans Hale**

**FIGURE 5B.**

NOTES. – *Parmelia neodiscordans* is a saxicolous foliose lichen that can be easily confused with the much more common and widely distributed *P. omphalodes* (L.) Ach. (Hinds & Hinds 2007). However, it produces fumarprotocetraric acid (K+ yellow to dingy brown), rather than salazinic acid (K+ yellow turning red) in the medulla (Hale 1987). It is endemic to North America and is a mainly Appalachian species known from North Carolina to Maine (Hinds & Hinds 2007). It is rare in Canada with only one known record from Ontario (Lewis & Brinker 2017).

*Specimens examined.* – **CANADA. QUÉBEC**. MRC DU HAUT-SAINT-FRANÇOIS: Hampden, on the Escarpements trail at Parc national du Mont-Mégantic, Franceville sector, on boulders, 29.v.2016, *A. Lavoie 160529-MM60* (CMMF), *A. Lavoie 160529-MM61C* (CMMF). MRC DE MATAWINIE: Sainte-Émélie-de-l'Énergie, Sentier Monette, Sérénité sector, in a fir forest near a stream, on a large boulder, 29.vii.2022, *A. Lavoie 220729-Z1515* (CMMF). MRC DE RIVIÈRE-DU-LOUP: Cacouna, Parc côtier de Cacouna, Passereaux trail, on rock face, 02.vii.2022, *A. Lavoie 220702-Z1514* (CMMF).

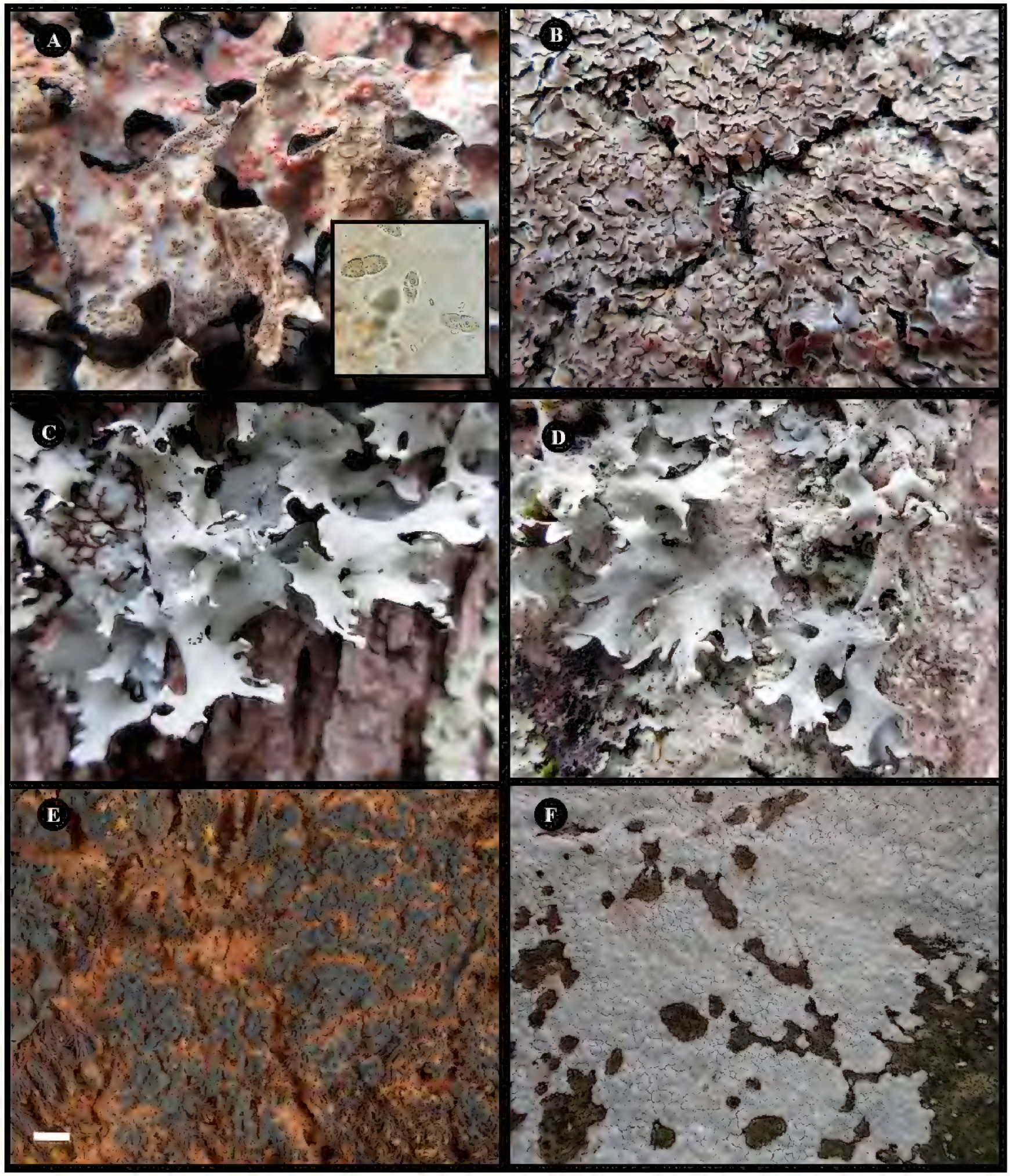


**Figure 5.** Photographs of selected species discussed in this contribution. **A**, *Ovicuculispora parmeliae*, with inset photograph showing macrospores and microspores (*J. Collin JC0289*, CMMF). **B**, *Parmelia neodiscordans*, in situ photograph by J. Collin (*A. Lavoie 160529-MM60*, CMMF). **C**, *Parmotrema margaritatum*, in situ photograph (*J. Collin JC0010*, CMMF). **D**, *Parmotrema reticulatum*, in situ photograph (*J. Collin JC0018*, CMMF). **E**, *Peccania tiruncula* photograph by K. Damboise (*C. Roy 0503797*, QFA). **F**, *Phlyctis petraea*, in situ photograph (*A. Lavoie HCAL15-045*, CMMF). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

***Parmotrema margaritatum* (Hue) Hale**

**FIGURE 5C.**

NOTES. – *Parmotrema margaritatum* is present across temperate eastern North America, though its distribution remains inadequately understood (Tripp & Lendemer 2020). It is rare in Canada, documented by only one published report in Ontario (Wong & Brodo 1990), in addition to two other records within the same province. One of these records was collected by Macoun in 1905 and subsequently confirmed through examination by R. T. McMullin (CLH 2023). The other one (*Imshaug 58434*, MSC[n.v.]) dates to 1975 and is from the east shore of Lake Superior, but it has not been verified in modern times. A single thallus was found in Québec despite several visits to the site reported here. This is a significant extension of its known range. Like *P. reticulatum* (Taylor) M. Choisy, this lichen produces salazinic acid (medulla K+ yellow turning to red) (Hale 1979). However, *P. margaritatum* is distinguished from *P. reticulatum* by the absence of rhizines on a wide band along the margins of the lower surface (Tripp & Lendemer 2020). In contrast, *P. stuppeum* (Taylor) Hale has narrow marginal soredia, while *P. margaritatum* has irregular round soredia, on short marginal lobes, with both species sharing the same chemistry (Hale 1979).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 20.xii.2020, *J. Collin JC0010* (CMMF, conf. A. Lavoie & I.M. Brodo).

***Parmotrema perlatum* (Hudson) M. Choisy**

NOTES. – *Parmotrema perlatum*, formerly referred to as *P. chinense* (Osbeck) Hale, is commonly found on trees, and sometimes on rocks, in temperate regions worldwide (Hinds & Hinds 2007). Its thallus has marginal cilia and linear marginal soralia (Hinds & Hinds 2007). Stictic acid is present in its medulla, which reacts PD+ orange and K+ yellow or orange (Gowan & Brodo 1988). We have not been able to locate herbarium specimens supporting the records that are supposed to be present at QFA (i.e., *Lepage 3631* [QFA 0270055] and *Marie-Victorin s.n.* [QFA 0557916]).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Acer rubrum*, 22.x.2022, *A. Lavoie* 221022-*Z1513* (CMMF, conf. I.M. Brodo).

***Parmotrema reticulatum* (Taylor) M. Choisy**

**FIGURE 5D.**

NOTES. – *Parmotrema reticulatum* is a temperate and subtropical corticolous lichen that can also occasionally be found on rocks (Hinds & Hinds 2007). It is characterized by the presence of salazinic acid (K+ yellow turning red) in the medulla, reticulate maculae at the edge of its lobes, changing into fine cracks towards the center of the thallus (Hinds & Hinds 2007) and by the presence of rhizines at the edge of the lower surface (Tripp & Lendemer 2020). Considered rare in New England (Hinds & Hinds 2007), in Canada *P. reticulatum* has been recorded for British Columbia (CLH 2023) and has been reported from Ontario (Brinker 2020) and Nova Scotia (Anderson 2014).

*Specimens examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 30.xii.2020, *J. Collin JC0018* (CMMF, conf. I.M. Brodo), 23.ix.2022, *A. Lavoie 220923-Z1435* (CMMF, conf. I.M. Brodo).

****Peccania tiruncula* (Nyl.) Henssen**

**FIGURE 5E.**

NOTES. – *Peccania tiruncula* is a minute cyanolichen found on rock and is characterized by its short knot-like lobes and subglobose spores (Tretiach & Schultz 2007). In our material the spores were hyaline, simple, broad ellipsoid to subglobose, 8–10 × 7–8 µm. It is commonly found in the southwestern United States (Tretiach & Schultz 2007) and the widely disjunct occurrence in the Gaspé Peninsula reported here is the only record from Canada (CLH 2023). It seems to be new in eastern North America (CLH 2023).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC LE ROCHER-PERCÉ: Percé, Petit mont Ste-Anne, south rock notch, north slope, near the summit, on *Grimmia teretinervis* on Carboniferous calcareous conglomerate wall, slightly seeping, facing west, 11.vii.1992, *C. Roy 92-1969-C et al.* (QFA, det. M. Schultz).

***_Phlyctis petraea_ R.C. Harris, Muscavitch, Ladd & Lendemer**

**FIGURE 5F.**

NOTES. – *Phlyctis petraea* was described by Muscavitch et al. (2017) and is a mostly saxicolous species, though it can rarely be found on bark. The thallus is white to pale gray with a felted appearance, almost always lacking apothecia and typically producing conspicuous scale-like or granular schizidia, and contains norstictic acid (K+ yellow turning red, P+ yellow) sometimes with additional stictic acid (P+ orange) (Muscavitch et al. 2017). It is known only from eastern North America (Muscavitch et al. 2017) and was previously known in Canada only from Ontario (Lewis 2020).

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, in a mature *Acer saccharum* forest, on boulder, 02.x.2015, *A. Lavoie HCAL15-045* (CMMF, conf. I.M. Brodo); Mont-Saint-Hilaire, E side, on a rocky escarpment, 02.x2015, *A. Lavoie HCAL15-046* (CMMF). MRC BROME-MISSISQUOI: Lac-Brome, bordering the Yamaska River, at Lac Brome outlet, on shaded boulders, 15.x.2022, *J. Collin JC0670* (CMMF).

***_Physconia grumosa_ Kashiw. & Poelt**

**FIGURE 6A.**

NOTES. – Originally described from Japan, the widespread occurrence of this species in North America was first recognized by Esslinger and Dillman (2010). Its North American distribution appears to be similar to that of *Physconia detersa* (Nyl.) Poelt (Esslinger & Dillman 2010). Amongst the *Physconia* species found in Québec, *P. grumosa* is characterized primarily by its granular to weakly coralloid isidia present along its lobe margins as well as the presence of dorsiventral lobules instead of true soredia (Esslinger & Dillman 2010). Examination of *Physconia* collections in other herbaria should yield more occurrences of this species from Québec.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Saint-Fabien, Ilet au Flacon, Parc national du Bic, on schist above high tide mark, facing N across St. Lawrence River, 18.viii.2014, *F. Anderson 162257* (QFA); Le Bic, Les Anses trail, Parc national du Bic, conifer dominated trail with tree-covered rock outcrops and mossy rock walls, on *Thuja occidentalis*, near base, 21.viii.2014, *F. Anderson 162307* (QFA); Le Bic, Le Chemin-du-Nord, Parc national du Bic, abundant upturned slate/shale outcrops, on slate/shale, 02.viii.2015, *F. Anderson 16425* (QFA). ADMINISTRATION RÉGIONALE KATIVIK: 60.7 km NNE of the village of Kangiqsualujjuaq, 9.8 km NNE of Tasiujaaluk bay, about 230 m E of Anse Gregson, marble hill, summit, on rocky button, 29.vii.2016, *J. Gagnon SF16-1535* (QFA, det. C. Roy). MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 11.xii.2020, *J. Collin 201211-Z1422* (CMMF, conf. A. Lavoie), 20.xii.2020, *J. Collin JC0011* (CMMF, conf. A. Lavoie), 24.iv.2022, *J. Collin JC0376* (CMMF, conf. R.T. McMullin); Sutton, Mont-Echo, on *Acer* sp., 28.v.2022, *A. Lavoie 220528-Z1281* (CMMF); Glen-Sutton, Au Diable Vert, in a *Acer rubrum*, *Tsuga* sp. and *Betula alleghaniensis* swamp, on *Acer rubrum*, 13.v.2022, *A. Lavoie 220513-Z1229* (CMMF), *A. Lavoie 220513-Z1237 & J. Collin* (CMMF). MRC DE RIMOUSKI-NEIGETTE: Saint-Marcellin, at the edge of the vernal pond, on *Acer rubrum*, 27.vi.2022, *A. Lavoie 220627-Z1449* (CMMF). MRC DE MATAWINIE: Sainte-Émélie-de-l'Énergie, in a *Abies balsamea* stand near the stream, Côte à Monette trail (Sentier National Matawinie), Sérénité FQME sector, corticolous on dead *Acer rubrum*, 31.vii.2022, *A. Lavoie 220731-Z1493* (CMMF). MRC DE KAMOURASKA: Saint-Germain-de-Kamouraska, at the shoreline of Île Dumais, on a boulder, 04.vii.2023, *J. Collin JC0923* (CMMF, conf. A. Lavoie).

***Physconia subpallida* Essl.**

**FIGURE 6B.**

NOTES. – *Physconia subpallida* is the only member of the genus in eastern North America that commonly produces apothecia, has lobules, a pale lower surface, and lacks isidia or soredia (Esslinger 1994). Found on deciduous tree bark, it is endemic to eastern North America, ranging locally from the Ozarks east to the Appalachian Mountains and north to Minnesota, New York, and Ontario (COSEWIC 2009). It is a listed species in Canada (Environment Canada 2016) that has undergone long-term declines due primarily to the loss of its mature hardwood forest habitat. In Canada, it is known from Ontario and was reported from a single site in Québec by McMullin et al. (2016). The collection reported here reconfirms its presence in Québec.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*,

**Figure 6.** Photographs of selected species discussed in this contribution. **A**, *Physconia grumosa*, in situ photograph (*J. Collin 201211-Z1422*, CMMF). **B**, *Physconia subpallida*, in situ photograph (*S. Brinker 9622*, CANL). **C**, *Placidium arboreum*, in situ photograph (*S. Brinker 9617*, CANL). **D**, *Punctelia appalachensis*, in situ photograph (*J. Collin JC0003*, CMMF). **E**, *Punctelia stictica*, in situ photograph by J. Collin (*A. Lavoie HCAL16-0016*, CMMF). **F**, *Pyrenidium aggregatum* (*S. Brinker 9619*, CANL). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

*Ostrya virginiana*, *Tilia americana* and *Pinus strobus* deciduous forest with limestone outcrops, corticolous on *A. saccharum*, 06.x.2022, *S. Brinker 9622* (CANL).

******Placidium arboreum* **(Schw. ex Michener) Lendemer**

**FIGURE 6C.**

NOTES. – *Placidium arboreum* is a large and distinctive squamulose lichen that is infrequent but widespread in temperate portions of eastern and southwestern North America (Brodo et al. 2001, as *P. tuckermanii* (Mont.) Breuss). It is mainly corticolous throughout its range, occurring among the furrows of bark on the bases of mature hardwoods (Brodo et al. 2001, Tripp & Lendemer 2020) though it has been reported from mossy calcareous rock outcrops elsewhere in the northern portion of its range (Brinker 2020). It can be distinguished from other species of *Placidium* by the conspicuous, dark, brush-like bundles of rhizohyphae that slightly elevate the squamules from the substrate, its overlapping lobes which range from 4–10 mm wide, and its substrate preference which includes tree bark and rock (Breuss 2010).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Thuja occidentalis* deciduous forest with limestone outcrops, terricolous on mossy limestone boulder, 06.x.2022, *S. Brinker 9617* (CANL).

******Placynthium stenophyllum* **var.** ***isidiatum*** **Henssen**

NOTES. – *Placynthium stenophyllum* var. *isidiatum* is a small, foliose cyanolichen that grows on limestone (Henssen 1963). Its thallus is isidiate, with lobes that have a pale underside (Henssen 1963). While *P. stenophyllum* var. *stenophyllum* has narrow lobes up to 2 mm long and 0.05–0.1 mm wide, the lobes of *P. stenophyllum* var. *isidiatum* can reach up to 3 mm in length and 0.2 mm in width (Henssen 1963). In Canada, it was first reported from Ontario by Lewis (2014) and was reported from the Ottawa region by Brodo et al. (2021a). Here, we report the first records for Québec.

*Specimens examined*. – **CANADA. QUÉBEC.** ADMINISTRATION RÉGIONALE KATIVIK: Nunavik, Parc national des Pingualuit, Lamarche River canyon, north shore, 2.1 km ESE of its confluence with the Puvirnituq River, 29.vii.2000, *J. Gagnon & N. Dignard LAM-43.01a* (QFA, det. A. Fryday). MRC DE RIMOUSKI-NEIGETTE: Saint-Anaclet, Chute Neigette sector, on calcareous cliff, 28.vi.2022, *A. Lavoie 220628-Z1533* (CMMF).

******Punctelia appalachensis* **(W.L. Culb.) Krog**

**FIGURE 6D.**

NOTES. – *Punctelia appalachensis* is a foliose lichen with a black lower cortex and is partly covered with lobules on its upper surface (Brodo et al. 2001). The dark lower cortex, as well as the C- medulla due to the presence of fatty acids, makes it easy to distinguish *P. appalachensis* from other *Punctelia* species (Brodo et al. 2001). This species is endemic to North America where it grows on bark and is commonly found in the Appalachian Mountains (Hinds & Hinds 2007). Apparently, this is the first published report for Québec, although there is a record in CLH (2023) from the MRC Val-Saint-François (1959, *R. Becking 5908243*, US[n.v.]). In Canada, this species is also known from Ontario (Brinker 2020), New Brunswick (Gowan & Brodo 1988) and Nova Scotia (Anderson 2014).

*Specimens examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, in a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, on *Fraxinus pennsylvanica*, 18.xii.2020, *J. Collin JC0003* (CMMF, conf. A. Lavoie), 24.iv.2022, *J. Collin JC0383* (CMMF, conf. A. Lavoie); Lac-Brome, in a swampy section of the Réserve naturelle du Boisé-Fisher, on *Acer rubrum*, 23.iv.2022, *J. Collin JC0371* (CMMF, conf. A. Lavoie); Glen-Sutton, Au Diable Vert, in a swamp, on *Betula alleghaniensis*, 13.v.2022, *A. Lavoie 220513-Z1236 & J. Collin* (CMMF), on a deciduous tree, *A. Lavoie 220513-Z1257 & J. Collin* (CMMF); Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Pinus strobus* deciduous forest with limestone outcrops, on *A. saccharum*, 06.x.2022, *S. Brinker 9620* (CANL).

******Punctelia stictica* **(Duby) Krog**

**FIGURE 6E.**

NOTES. – *Punctelia stictica* is a saxicolous species (Brodo et al. 2001). Its thallus is a distinctive brown to gray-brown color, and it has conspicuous, abundant white pseudocyphellae, as well as laminal soralia with granular soredia (Egan & Aptroot 2004). In Canada, it is quite common in British Columbia,

particularly over rock in open coastal outcrops (Goward et al. 1994), and on the north shore of Lake Superior on coastal rock outcrops (Brinker 2020). The disjunct occurrences reported here are all from the Parc national du Bic on the maritime south shore of the St. Lawrence estuary. They are the first records for Québec and eastern North America.

*Specimens examined*. – **CANADA. QUÉBEC.** MRC DE RIMOUSKI-NEIGETTE: Le Bic, Pointe aux Épinettes, Parc national du Bic, large S-facing exposed rock at beach edge, on conglomerate, 20.viii.2016, *F. Anderson 16554* (QFA); Le Bic, Cap-à-l'Orignal, Parc national du Bic, on exposed rock at beach edge, 21.viii.2016, *A. Lavoie HCAL16-0016* (CMMF); Saint-Fabien, Ilet au Flacon, Parc national du Bic, on shale at beach edge, 25.viii.2016, *A. Lavoie 160825-Z0841* (CMMF); Saint-Fabien, Ilet au Flacon, Parc national du Bic, at the eastern shore, on dry and exposed shale, 20 m from the forest, 25.xiii.2017, *J. Gagnon Bic17-3155* (QFA).

****†*Pyrenidium aggregatum* K. Knudsen & Kocourk.**

**FIGURE 6F.**

NOTES. – *Pyrenidium aggregatum* is a pyrenocarpous lichenicolous fungus growing on *Phaeophyscia* and *Physcia*, characterized by developing conspicuous galls with immersed perithecia, and brown, three-septate spores (Knudsen & Kocourková 2010). It occurs in mesic forests, freshwater wetlands and mangrove swamps throughout eastern United States from Florida north to Maine and west to the Ozarks (Knudsen & Kocourková 2010, Lendemer 2017, Seaward et al. 2017). The known hosts are *Phaephyscia adiastola* (Essl.) Essl., *P. rubropulchra* (Degel.) Moberg and *Physcia atrostriata* Moberg. Our specimens match the characteristics from the protologue including the convex galls that are concolorous with the host thallus, the absence of indications of necrosis in the host, and dark brown, three-septate spores, 16–20 × 6.5–8.3 µm. *Phaeophyscia pusilloides* is reported as a new host.

*Specimen examined*. – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Saint-Armand (Philipsburg), Sanctuaire George H. Montgomery, 2 km E of Missisquoi Bay, upland *Acer saccharum*, *Ostrya virginiana*, *Tilia americana* and *Thuja occidentalis* deciduous forest with limestone outcrops, lichenicolous on *Phaeophyscia pusilloides* and *P. rubropulchra* on the bark of *A. saccharum*, 06.x.2022, *S. Brinker 9619* (CANL); Lac-Brome, Auberge du Joli-Vent hiking trail, in a mature, well-lit mixed forest with moist ground, lichenicolous on *Phaeophyscia rubropulchra* on a boulder, 07.v.2022, *J. Collin JC0406* (CMMF, det. A. Huereca.)

*******Pyrenopsis grumulifera* Nyl.**

NOTES. – *Pyrenopsis grumulifera* is characterized by its blackish crustose thallus with perithecioid apothecia found on moist siliceous rocks (Jørgensen 2012b). Its asci contain variable numbers of spores (8 to 64) that are hyaline and simple (Jørgensen 2012b). While it is common in Europe, it is known in North America only from southwest Alaska and Greenland (Thomson 1997) where it was reported as *P. myriospora* E. Dahl. Our specimen had a relatively thick thallus, granulose in texture, separated into areoles, with many displaying punctiform openings leading to sunken ascomata. The exciple was not evident or is very thin, the epihymenium and hypothecium were hyaline, paraphyses sparse and branched, asci pyriform with a thickened tip, containing 30 to perhaps 64 spores, the spores were 5.0–6.0 × 2.0-2.5 µm and the photobiont was *Gleocapsa* with distinct sheaths that were K+ purple. This may be the only *Pyrenopsis* with polysporous asci and it is the only polysporous species of the genus in the arctic flora according to Thomson (1997).

*Specimen examined*. – **CANADA. QUÉBEC.** MRC DE LA HAUTE-GASPÉSIE: Mont Albert, trail to the north summit (1083 m), growing with *Ephebe hispidula*, on pebbles in depression in dry tundra, 07.viii.1971, *I.M Brodo 18555* (CANL).

***Rhizocarpon timdalii* Ihlen & Fryday**

**FIGURE 7A.**

NOTES. – *Rhizocarpon timdalii*, a species in the *R.* "*obscuratum*" group from northeastern North America is found on acidic rocks (Ihlen & Fryday 2002). It is most likely to be confused with *R. reductum* Th. Fr, but can be distinguished by its blue-green epihymenium, small convex areoles, and longer, broader spores, which can measure up to 42.5 (–48) × 20(–23) µm, while the spores of *R. reductum* can reach 34(−40) × 15.5(−18) µm (Ihlen & Fryday 2002). The examined material fits well the description of *R. timdalii* (Ihlen & Fryday 2002). There are three previously unpublished Québec records (CLH 2023) based on collections made at the same location and on the same day in the MRC Le Haut-Saint-Laurent (*W.R. Buck 63967, W.R. Buck 63970*, *R.C. Harris 61655*, all NY [n.v.]). It is newly reported here from Québec.

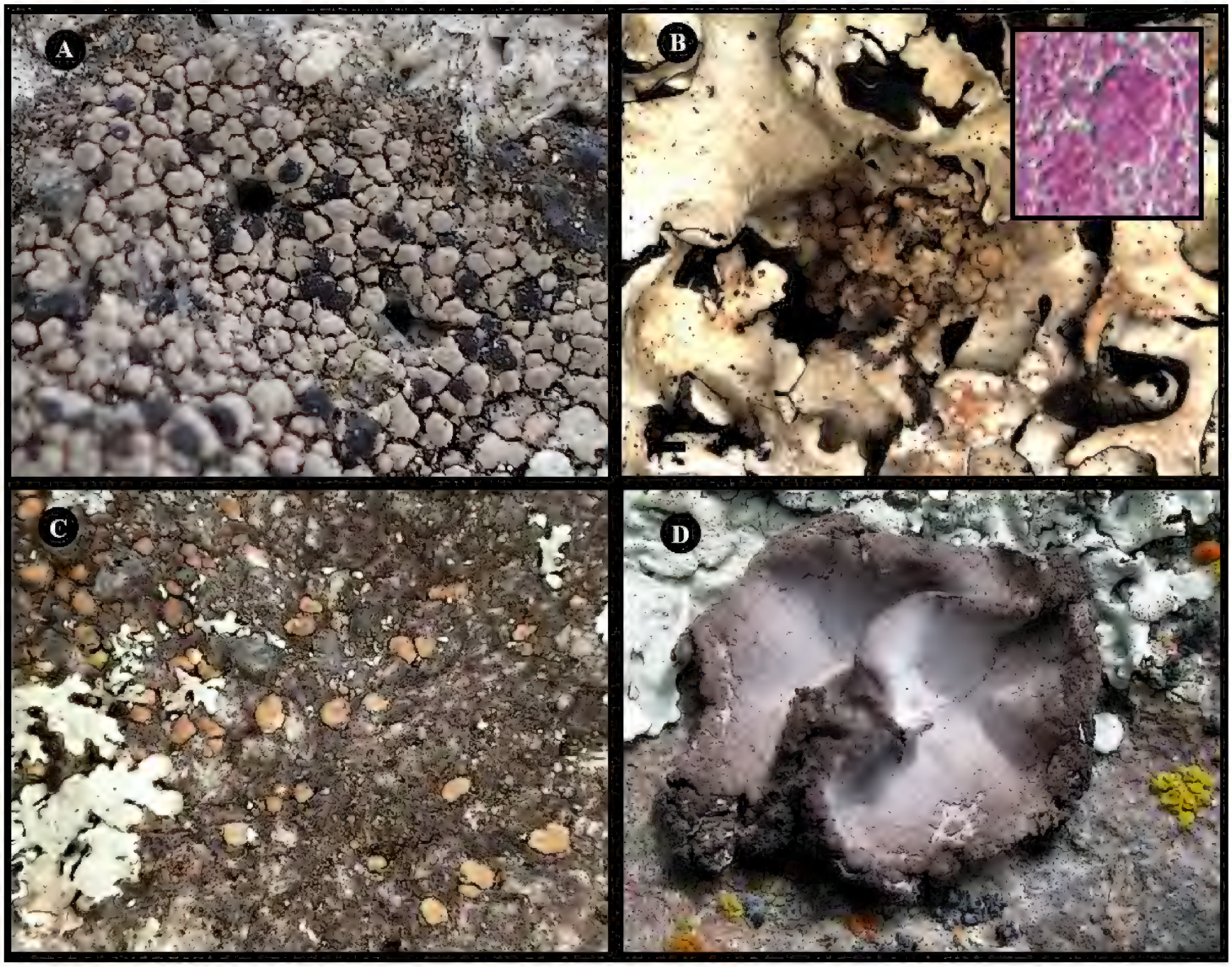


**Figure 7.** Photographs of selected species discussed in this contribution. **A**, *Rhizocarpon timdalii*, in situ photograph (*A. Lavoie HCAL15-282*, CMMF). **B**, *Tremella flavoparmelia*, with inset showing basidium with one longitudinal septum, photograph by A. Huereca (*J. Collin JC0308-2*, CMMF). **C**, *Trimmatothelopsis dispersa*, in situ photograph (*A. Lavoie 160301-Z0007*, CMMF). **D**, *Umbilicaria hirsuta*, in situ photograph (*J. Collin JC0164*, CMMF). Scale bars when present = 1.0 mm. Field photographs were taken without scale.

*Specimens examined*. – **CANADA. QUÉBEC**. ADMINISTRATION RÉGIONALE KATIVIK: Nunavik, 137 km S of Kuujjuaq, low limestone hill, exposed summit, on a small rock boulder, 04.viii.2012, *J. Gagnon SF12-9118* (QFA, det. A. Fryday). MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, Dieppe summit, red oak forest, on exposed rock, 23.viii.2015, *A. Lavoie HCAL15-282* (CMMF), 01.iii.2015, *A. Lavoie HCAL15-283* (CMMF, conf. I.M. Brodo). MRC DE RIVIÈRE-DU-LOUP: Cacouna, Parc Fontaine Claire, on shale at the edge of the bay, 25.vi.2023, *J. Collin JC0848* (CMMF, conf. A. Lavoie).

***Rimularia badioatra* (Kremp.) Hertel & Rambold**

NOTES. – In eastern North America, *Rimularia badioatra* is widespread in the Appalachian Mountains (CLH 2023) where it can be found on non-calcareous rocks in shaded or sheltered habitats (Tripp & Lendemer 2020). It is a very distinctive, if overlooked, species that has brown to brown-gray areoles, gyrophoric acid the medulla (C+ pink) and apothecia with dark brownish-black discs that vary from sunken and immersed in the thallus to nearly sessile with thalline margins (Brodo et al. 2021a, Tripp & Lendemer 2020). The hyaline, simple spores in our specimen measured 15–18.1 × 7.5–12.5 µm. In Canada, it is known from New Brunswick (CLH 2023) and from a single site in Québec (Brodo et al. 2021a). This is the second report for Québec.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, Dieppe summit, red oak forest, on exposed rock, 05.vi.2015, *A. Lavoie HCAL15-246* (CMMF), *A. Lavoie HCAL15-255* (CMMF).

***Trapeliopsis pseudogranulosa* Coppins & P. James**

NOTES. – *Trapeliopsis pseudogranulosa* grows on sheltered acidic substrata, especially on mosses (Purvis & Smith 2009). Its thallus is sorediate with orange patches of pigment reacting K+ purple (Brodo 2016). In eastern North America, it has been reported from Ontario (Brodo et al. 2013), and there are specimens from Maine and New Brunswick (CLH 2023). *Trapelia granulosa* (Hoffm.) Lumbsch also grows on acidic substrates, but is typically a species of soil and humus and while it can also have patches of the thallus that appear orange pigmented, these are K- (Brodo et al. 2001, Lendemer & Noell 2018, Tripp & Lendemer 2020).

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DU HAUT SAINT-FRANÇOIS: Hampden, Parc national du Mont-Mégantic, Franceville sector, Escarpements trail, on mosses on rock cliff, 30.v.2016, *A. Lavoie* M16059 (CMMF).

****†Tremella flavoparmeliae* Diederich, B.P. Hodk. & Millanes**

**FIGURE 7B.**

NOTES. – This heterobasidiomycete lichenicolous fungus induces the formation of large, brownish, bullate galls on the thallus of the host, *Flavoparmelia caperata* (L.) Hale (Diederich et al. 2022). It had been known for over a decade but remained unnamed due to lack of mature basidia (Diederich 2007). However, with access to numerous well-developed collections, it was recently described from the Appalachians and Midwest in the United States (Diederich et al. 2022). Although its host is particularly common in Europe and other parts of the world, it was not reported from those regions (Diederich et al. 2022). Our report is a considerable range extension from its nearest previously known occurrences in Minnesota and North Carolina (Diederich et al. 2022). Our specimen has the diagnostic characteristics of the species by forming large, strongly convex, bullate galls with a brown tinge compared to the host thallus, and by having subspherical to ellipsoid basidia with one longitudinal septum.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC BROME-MISSISQUOI: Lac-Brome, at the edge of a swamp with *Fraxinus pennsylvanica*, *Acer rubrum* and *Thuja occidentalis*, lichenicolous on *Flavoparmelia caperata*, 12.i.2022, *J. Collin JC0308-2* (CMMF, det. A. Huereca), 10.xii.2022, *J. Collin JC0719* (CMMF).

****Trimmatothelopsis dispersa* (H. Magn.) K. Knudsen & Lendemer**

**FIGURE 7C.**

NOTES. – *Trimmatothelopsis dispersa* (≡ *Acarospora dispersa* H. Magn.) is an *Acarospora*-like saxicolous species that is widespread in the eastern United States according to Knudsen and Lendemer (2016), who provided a full description. According to those authors, it could be confused with a member of the *Myriospora smaragdula* group, were it not for its small reddish-brown apothecial discs, which result from an incurving parathecium and might be misconstrued as pycnidia ostioles. The Québec specimen agrees well with the published description cited above.

*Specimens examined.* – **CANADA. QUÉBEC.** MRC DE LA VALLÉE-DU-RICHELIEU: Mont-Saint-Hilaire, Dieppe summit, red oak forest, on exposed rock, 12.vii.2015, *A. Lavoie HCAL15-255* (CMMF), 01.iii.2016, *A. Lavoie 160301-Z0007* (CMMF).

***Umbilicaria hirsuta* (Sw. ex Westr.) Ach.**

**FIGURE 7D.**

NOTES. – *Umbilicaria hirsuta* grows on siliceous rocks, most often in the presence of seeping water (Hinds & Hinds 2007). It is recognized by its granular soredia developing near the margins from the rupture of the upper cortex and its lower cortex with abundant rhizinomorphs (Brodo et al. 2001). It is the only sorediate *Umbilicaria* in North America (Brodo et al. 2001) and has previously been reported from the Abitibi region in Québec (Goward et al. 1998). Furthermore, two historical references from Québec were identified in the literature, specifically from the MRC La Haute-Côte-Nord as documented by Drummond (1869) and from the MRC des Laurentides as reported by Durban (1861). It is important to note that despite their inclusion in the literature, no voucher specimens are known for these records. Our specimen thus represents the second documented occurrence in Québec.

*Specimen examined.* – **CANADA. QUÉBEC.** MRC DE MEMPHRÉMAGOG: Orford, close to the summit (850 m) at Parc national du Mont-Orford, on an exposed rock wall, 16.vi.2021, *J. Collin JC0164* (CMMF, conf. A. Lavoie & I.M. Brodo).

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## APPENDIX – DISTRIBUTION MAPS FOR SPECIES DISCUSSED IN THIS STUDY

In this section distribution maps are provided for the species discussed in this study. Québec is depicted in light gray, bordered by Ontario, the Atlantic provinces, Labrador, and the United States, all shown in dark gray. Red dots indicate new records, while black dots represent previously known records, with georeferenced data obtained from CLH (2023). In some cases, additional records from GBIF (2023) and non-georeferenced literature sources have been incorporated for the province of Québec, though not beyond its borders. The maps are based on the same template used in Figure 1.

*Abrothallus microspermus*

*Acarospora rosulata*

*Acarospora subfuscescens*

*Acrocordia cavata*

*Agonimia opuntiella*

*Biatora pontica*

*Biatora sphaeroidiza*

*Catillaria lenticularis*

*Cercidospora epipolytropa*

*Cladonia norvegica*

*Crespoa crozalsiana*

*Endocarpon petrolepideum*

*Epithamnolia pertusariae*

*Heppia adglutinata*

*Heterodermia hypoleuca*

*Heterodermia squamulosa*

*Hypotrachyna showmanii*

*Lecanora nothocaesiella*

*Lecanora poliophaea*

*Leproplaca cirrochroa*

*Leptogium rivulare*

*Leptorhaphis lucida*

*Lithographa tesserata*

*Micarea globulosella*

*Micarea misella*

*Muellerella hospitans*

*Naetrocymbe rhyponta*

*Ovicuculispora parmeliae*

*Parmelia neodiscordans*

*Parmotrema margaritatum*

*Parmotrema perlatum*

*Parmotrema reticulatum*

*Peccania tiruncula*

*Phlyctis petraea*

*Physconia grumosa*

*Physconia subpallida*

*Placidium arboreum*

*Placynthium stenophyllum* var. *isidiatum*

*Punctelia appalachensis*

*Punctelia stictica*

*Pyrenidium aggregatum*

*Pyrenopsis grumulifera*

*Rhizocarpon timdalii*

*Rimularia badioatra*

*Trapeliopsis pseudogranulosa*

*Tremella flavoparmeliae*

*Trimmatothelopsis dispersa*

*Umbilicaria hirsuta*